American Machinist

From the Chief of Ordnance

Major-General C. C. Williams

Asks Co-operation of Our Readers

TWO years before the war—to be exact in January, 1915—the *American Machinist* set itself the task of educating the American manufacturing public toward preparedness by the widespread publication of methods of ordnance manufacture. This policy it has consistently followed up to the present time, with the result that educational work of exceeding importance to our public safety has been accomplished.

Now that the excitement of actual warfare is over there is a natural tendency to forget what we have learned. To counteract this tendency and to conserve our present public asset of knowledge of ordnance engineering and manufacture, the *American Machinist* is initiating a new editorial department entitled "United States Army Ordnance News." In so doing it is in my estimation performing a public service fully as important as its previous service during the war.

I urge upon American manufacturers who have made ordnance material, upon civilian engineers who have had to do with its design or manufacture, upon officers who came into the Ordnance Department from civilian life and who have gone or are now going back to their former occupations, that they contribute their experiences and add to their experience through these columns, so that the knowledge of ordnance that we have gained as a nation during the past 20 months may not be lost or considered an exclusive prerogative of those who remain in the regular establishment. The Government arsenals and the Ordnance Department are but a nucleus for the greater organization of our manufacturers and civilian engineers. It was these manufacturers and these engineers who made possible the accomplishments of the past, and it is to these men that we must look in the future. Their knowledge of ordnance engineering and manufacture is our greatest assurance of real preparedness.

Washington, D. C.
Jan. 23, 1919

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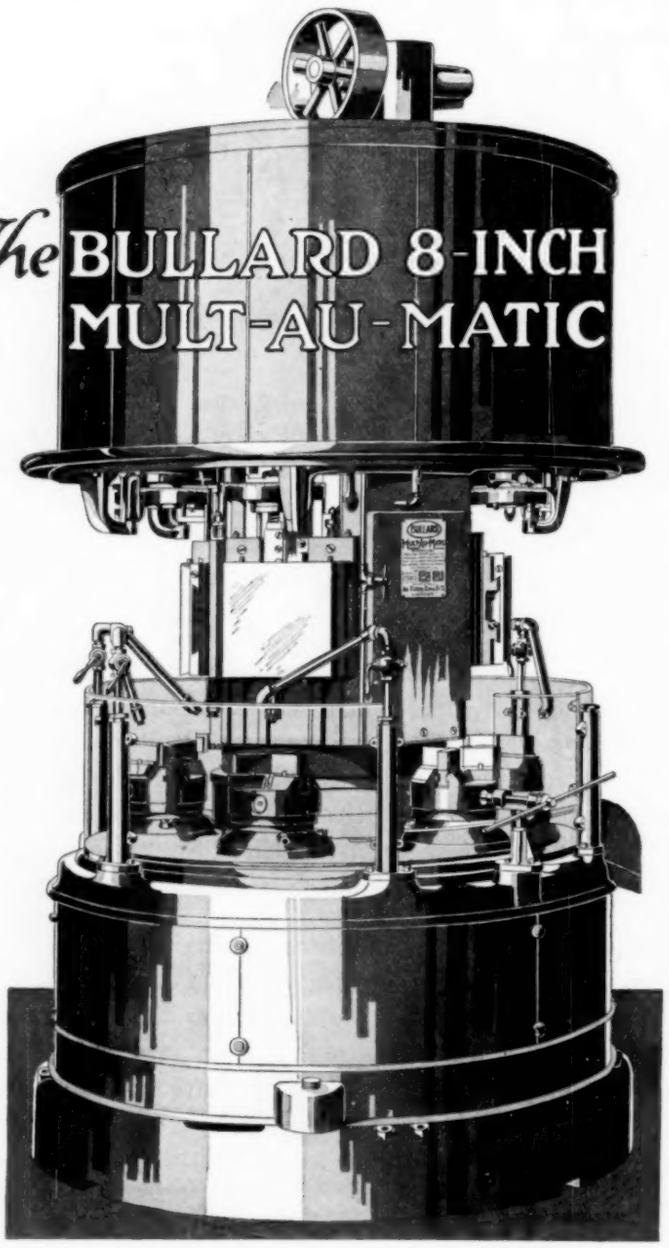
February 6, 1919 American Machinist Vol. 50, No. 5

The BULLARD 8-INCH MULT-AU-MATIC



Five years ago the American Machinist announced to the public the original 14-in. Bullard Mult-Au-Matic, which was the first station-type machine tool built in America for the market. In this issue we present to the public for the first time the new Bullard 8-in. Mult-Au-Matic. This new and smaller machine, while it follows the general principles of operation of its 14-in. predecessor, contains 2500 fewer parts, but many new features which will bring this new type of Mult-Au-Matic into an entirely new field of work.

THE new Bullard 8-in. Mult-Au-Matic, like its larger predecessor which was the pioneer station-type machine tool, is the development of the idea that automaticity in machine tools need not be accompanied by restricting specialization. The demonstration of this idea in the 14-in. machine, having successfully passed its five-year period of probation, and having been tested in some 150 installations, the fruition of that idea in a second size of the same type of machine is of especial interest. No machine tool has a wider range of work than the engine lathe. No machine tool is more simple in its tooling than the engine lathe, with its single-pointed tool fed longitudinally, transversely or at any angle by means of its compound rest. The idea behind the Mult-Au-Matic is that of combining the breadth of range and simple tooling of the engine lathe with the precision and time saving of a strictly automatic process; in reality it is the making automatic of six engine lathes working in sequence and operated by one man whose duties consist of loading and unloading. The one phase of lathe operation which has not been included in the function of this machine is turning between centers. The first impression one gets in watching any one of the five working stations of the 8-in. Mult-Au-Matic is that here is an engine lathe standing on its head and apparently benefiting by its change in position, for all of the customarily manually operated lathe motions are followed out without human guidance and hence also without the possibility of human lapses in time and accuracy. The field of the 8-in. Mult-Au-Matic includes all classes of castings, forgings or bar-stock sections, cut to length, coming within its capacity and which require boring, turning, facing or threading operations, either singly or in combination. Briefly it comprises six independent vertical lathes automatically operated in combination on a series of pieces of the same form and size, all of the sequence of operations, including chucking, being performed simultaneously. Thus there is produced a completely finished piece in the time required for the longest operation of the sequence plus the few seconds needed for the indexing of the carrier and its spindles from one station to the next. The six independent work-holding spindles

are mounted on a carrier, or turret, which revolves around a central column having six faces, the first of which, being the loading station, is blank. On the remaining five faces are mounted tool-carrying slides which are independently adjustable in amount, rate and direction of movement.

The base, which is cylindrical in form, forms a rigid surface plate on which is mounted the machine proper. This base, as shown in Fig. 1, is divided into two sections, the lower of which serves as a tank of large capacity for cutting lubricant or "coolant" and the upper as a reservoir for the lubricating oil circulated throughout the machine. Within each reservoir is an independent power pump for circulating its contents. The column, a rigid cylindrical unit, is firmly secured to the base. On its lower end is formed the main, or central, bearing for the spindle carrier, or turret. Within this section is incorporated the indexing and turret registry mechanism. On its upper end, hexagonal in form, are mounted the independent tool-carrying heads, and on the head of the column and firmly secured thereto is mounted a strongly ribbed base for the feed and driving mechanism, an interior view of which is shown in Fig. 4. The carrier, or turret, in which are mounted the work-spindles and which is shown in Fig. 3, embodies in its construction facilities for the readjustment of the spindles in relation to each other as well as to the registry mechanism. The bearing of the carrier on the column is tapered to provide a fine adjustment at this point.

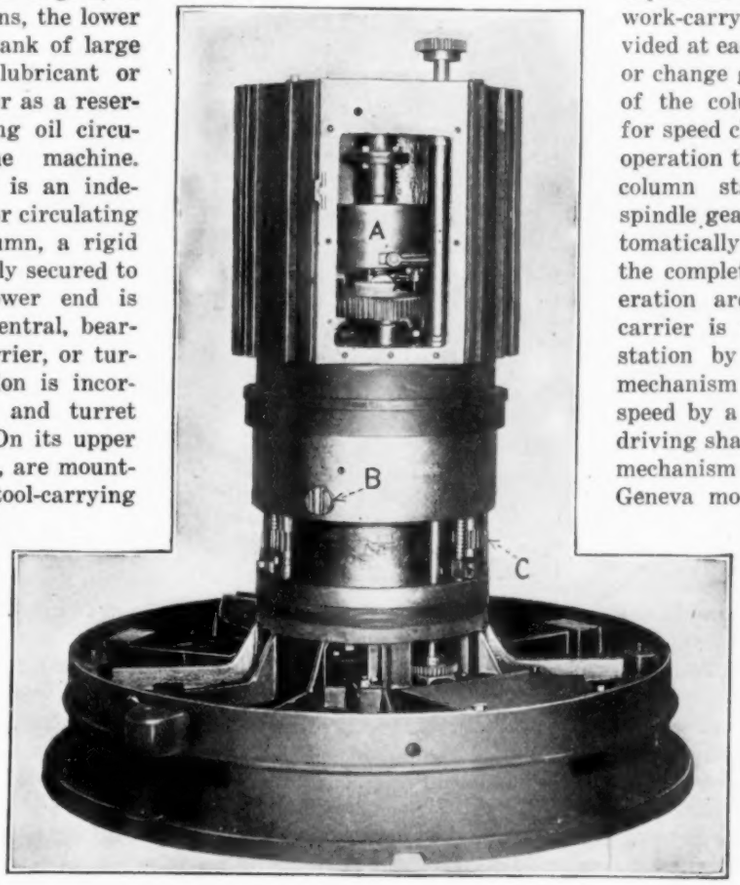


Fig. 1. Surface-plate form of machine base and hexagonal column. The base contains an upper and lower compartment, the former containing the supply of lubricating oil and the latter the coolant. Each compartment has its independent circulating pump. The main controller drum can be seen at A, the locking pin at B and one of the work-spindle driving pinions at C.

The controlling drum, carrier indexing mechanism, registry master pin and carrier binder are contained within the column. These parts are readily accessible for inspection or adjustment by the removal of a plate at the loading station and are shown at *A* in Fig. 1.

The individual feed works, which are illustrated in Fig. 4, are units in construction and serve as supports for the top plate, on which is mounted the driving-pulley bracket. A 10-hp. motor is sufficient for all conditions of load.

In type and proportion the work spindles follow closely the design of those used in the Bullard boring mills and vertical turret lathes. Two cylindrical bearings are provided to absorb side strains and a self-centering conical thrust bearing at the upper end of the spindle is provided to take care of the vertical pressures. The spindle head is in the form of a plain faceplate, to which may be secured specially designed three-jaw chucks, as illustrated in Fig. 2, or special work-holding fixtures as required. The spindles are driven by spur gearing and each spindle gear is mounted between adjustable friction surfaces which serve as a safety device. Means for obtaining widely variable independent selective speeds for work-carrying spindles are provided at each station. Transformer or change gears located at the head of the column provide the means for speed changes. In the indexing operation the driving pinions at the column stations and the work-spindle gears in the carrier are automatically disengaged, and after the completion of the indexing operation are again engaged. The carrier is rotated from station to station by power. The indexing mechanism is driven at a constant speed by a connection to the main driving shaft of the machine. This mechanism (a modification of the Geneva motion) actuates the carrier from station to station without jar, providing the necessary acceleration and retardation to advance the carrier and bring it to rest. Continued accuracy in the registry of the carrier and spindles with the tool stations is absolutely essential. Of equal importance is the ability to correct inaccuracy, should it arise, in any one of the registry positions, without affecting the others. This object is attained as follows: Each registry pin is tightly fitted to the carrier, one serving for each work spindle. The opposing master pin, located in the column, is actuated by a cam on the controlling shaft. The registry pins are milled to give an inclined contact face, those in the carrier forming a wedge, while the master pin presents a mating jaw. A slot milled in the master pin provides a limited amount of spring opening and, as it is forced into engagement with the opposing wedge, the freedom required for its sliding fit in the column is eliminated, thus insuring accuracy in registry.

The carrier binder, mounted in the column, is actuated in conjunction with the master registry pin, and serves not only to bind the carrier in its indexed position, but also to take up such freedom in the bearing of the carrier on the column as is required in indexing the carrier from station to station. The carrier is brought to rest by the indexing device before the registry pins

are engaged with the purpose of eliminating shock and jar. The tool-carrying heads are mounted on the faces of the column at the five work stations. These heads are entirely independent in direction, amount and rate of movement, and consist of a main slide gibbed to the column, on which is mounted a secondary slide to which the tool combination may be secured. The secondary slide may be swiveled to 90 deg. either way of the work axis and rigidly located at any angle. For straight boring, reaming and turning, the secondary slide is locked at zero and the entire head moves as a unit throughout the distance required to complete the operation, meets its stop and is returned. For taper boring, angular turning or facing at any angle with the work axis the secondary slide is set at the desired angle. The entire head is advanced to the work, the main slide brought to rest by a stop and locked in position. The motion is then taken up by the secondary slide which is fed the distance required, brought to rest by an adjustable stop and returned through its original path. The heads are rapidly advanced to the point where feed should begin, the feeds then engaged at the predetermined rate per revolution and at the completion of the feed movement are rapidly returned. The rate of advance and return is constant regardless of feed or spindle speed, but the point of change from rapid advance to feed is adjustable. The rate of feed at each station is determined by change gears shown at *D* in Fig. 4. Any head may be geared up to feed a determined thread pitch.

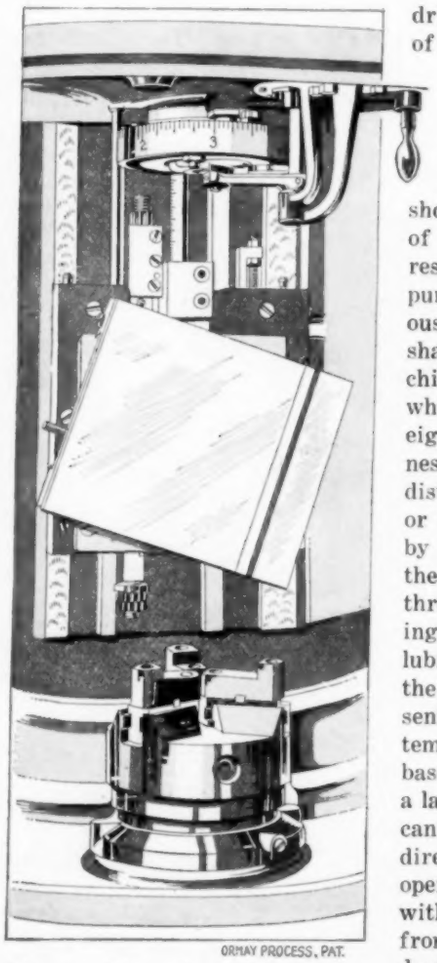


Fig. 2. View of one of the five working stations, showing close-up of compound tool slide

Each tool head having independent feed works has as well an independent manual control. At any point in its advance motion the feed may be disengaged and again engaged. This feature is intended to accomplish a saving in the time required for setting up a job. The main drive shaft revolves at a constant speed and is in motion so long as power is applied. The lubricating-oil circulating pump and drive shaft for the indexing mechanism directly geared thereto are therefore also in continuous motion at constant speed. The mechanism for rapid advance and return of the tool heads, independent from and yet a part of the feed works, is also directly connected with the main drive shaft and therefore driven at a constant speed irrespective of the speed of work spindles or rate of feed. The time element of all automatic motions is therefore constant and cannot be varied or adjusted by the operator. The lubrication of the Mult-Au-Matic shows careful planning. In the base of the machine, which forms a large reservoir, is located the circulating pump, which is directly and continuously driven from the main drive shaft. Forced to the top of the machine the oil passes through a filter which removes all impurities and foreign matter and insures its cleanliness. After filtration it is led to the distributing reservoir in the top plate or motor base, from which it is fed by gravity in large streams first to the feed works and thence down through the entire machine, all bearings and gears being under flooded lubrication. As an integral part of the machine and included as an essential element in its design is the system of chip and water guards. The base of the machine, as stated, forms a large reservoir for the cutting lubricant or coolant, the circulation pump, direct connected to the main drive and operable when required, is mounted within the base. Lubricant drawn from the reservoir is forced through ducts in the base and is delivered at the cutting tools by adjustable nozzles mounted on the chip-guard stanchions within which is an extension of the ducts in the base. The lubricant, after performing its function, is returned by channels in the carrier to the point of chip discharge and with the chips is delivered to a separating and settling tank located at the discharge chute, returning clean lubricant therefrom to the reservoir in the base.

Owing to the principle on which the Mult-Au-Matic operates, the total time for machining a piece on it is the time of the longest single operation plus the slight amount of time required for indexing. Fig. 5 shows a developed view and Fig. 6 the tooling diagram for a taper roller-bearing cup and gives the speeds and feeds for the various operations. Total machining times of 1 min. or less are not infrequent. The following are the principal dimensions and specifications of the 8-in. Mult-Au-Matic: Capacity, 8 in. in diameter by 6 in. in height; chuck, 10 in. in diameter, with 8-in. capacity; spindle

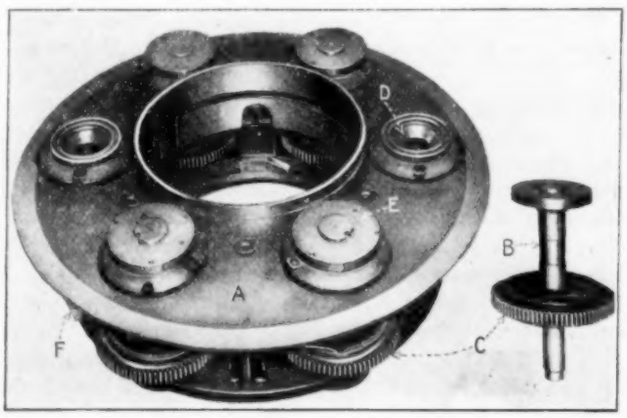


Fig. 3. Work-spindle carrier with four spindles assembled. The spindle B is driven by the gear C, which meshes with the pinion shown at C in the halftone, Fig. 1

head, 9¾ in. in diameter; spindle speeds (standard) 33, 42, 48, 66, 82, 100, 122, 150, 208, 233 and 300 r.p.m; movement of tool heads, 6 in. vertically, 3 in. horizontally or angularly; feed rates per revolution (standard), 0.0067, 0.0086, 0.0096, 0.0133, 0.0162, 0.02, 0.0244, 0.03 0.0415, 0.0467, 0.06 in.; main drive pulley, 14 x 4½ in., 760 r.p.m.; motor 10 hp., 1800 r.p.m.; projected floor space, machine only, 67 in. in diameter; chip container, 29 in. x 15 in.; height, without motor, 137 in.; net weight, 18,000 lb. One of the features intended to promote flexibility of setup and at the same time decrease the expense of tool equipment is the use of transverse and angular feeds. The incorporation of these features does away with the necessity of sweep cutters for facing. The total time for any piece machined on the Mult-Au-Matic is that required for the longest operation performed on any one head plus the slight time required to index the work-spindle carrier mechanism from station to station. This means that one particular working station is always the limiting station, and since each tool head at each station rises as soon as it has performed its work, this limiting station is determined at a glance and it is also very easily noticed how far behind the other heads the limiting station is in its performance. Thus the scheme of operation on this machine for maximum efficiency in connection with large lots is to devise ways and means to reduce the time taken by the limiting station at its work either by subdividing the cuts or revising the method of tool operation. One feature which goes a long way

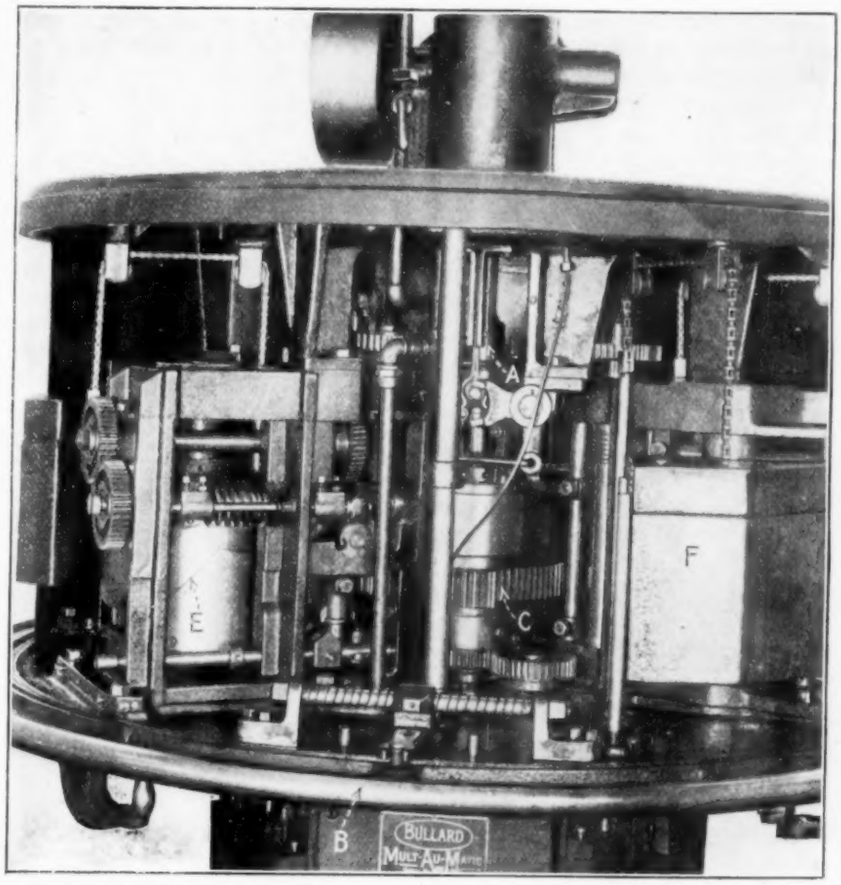


Fig. 4. Inside view of the "upper story" of the 8-in. Mult-Au-Matic with sheet-metal splash guards removed. A is the main drive shaft; B, the manual-control clutch ring; C, work-spindle drive; D, feed change gears; E, quick-return cam on feed head; F, counterweight on fifth station of the machine

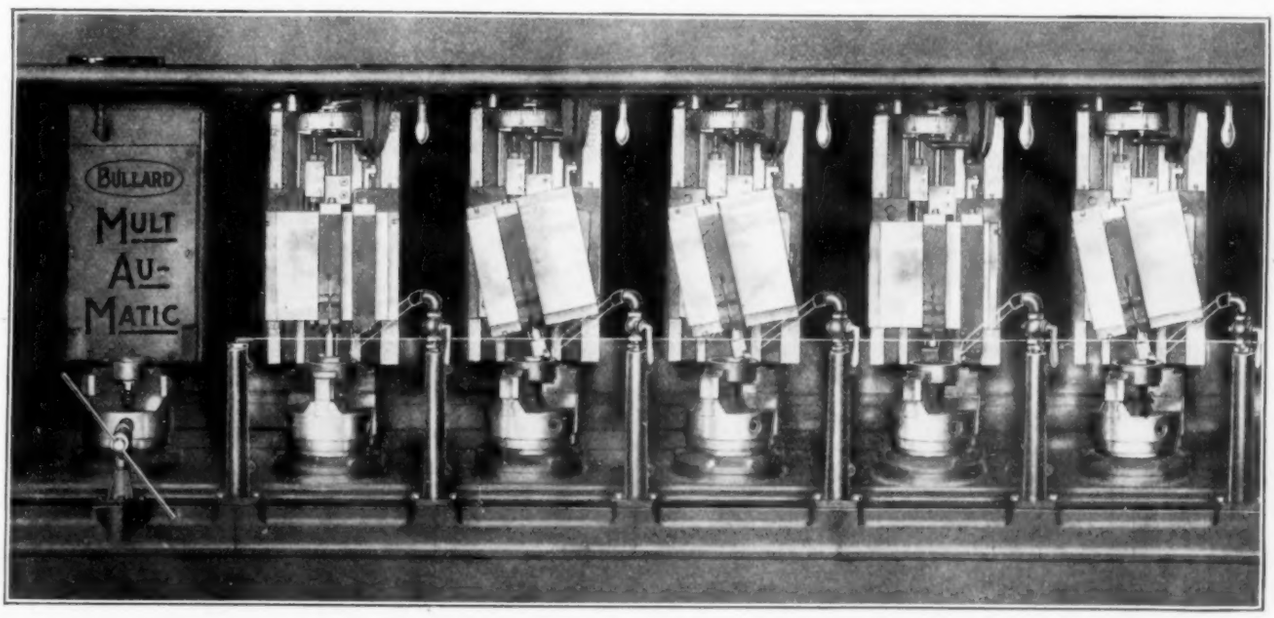


Fig. 5. Developed view of the loading station and five working stations, showing the Mult-Au-Matic tooled for machining a conical roller-bearing race

toward the elimination of lost time is the use of independent feeds and speeds for each station. It is an obvious fact that the rate of feed and speed best suited to a drill working in alloy steel is destructive to a reamer working in the same material. A shouldering or recessing tool is quickly ruined if fed at the same rate of feed used for a roughing cut, and if the feed of a roughing tool is reduced to accommodate that suitable for a parting tool its productive efficiency is of course correspondingly reduced.

Motor drive is provided for this machine when desired; in such cases the motor is mounted on the top of the feed works "umbrella," which is the name given to the top plate and which serves not only as a cover for the entire feed works but also as a means of securing them in a single unit.

Sequence and Interrelation of Functions of the 8-Inch Mult-Au-Matic

STARTING FUNCTIONS

1. Power is applied to the constant-speed main drive pulley which actuates, (a) the lubricating-oil circulating pump; (b) the coolant circulating pump; (c) the controller clutch ring within the column, through which all automatic functions are timed and actuated.

2. Main clutch is manually operated, applying power to work-spindle drive.

3. Safety lock at loading station is manually operated, releasing control drum.

OPERATING FUNCTIONS

4. Control drum advances and bell crank motion engages plunger with slot in constantly revolving controller clutch ring.

5. Secondary drive clutch automatically disengages, bringing work spindles to rest.

6. Carrier binder is released by cams on central control shaft and master registering pin is withdrawn.

7. The carrier is advanced one station by Geneva motion, the driving pinions and work spindle gears being automatically disengaged and reëngaged at the new station.

8. The master registering pin is engaged by cams on central control shaft, the carrier binder operates and indexing is completed.

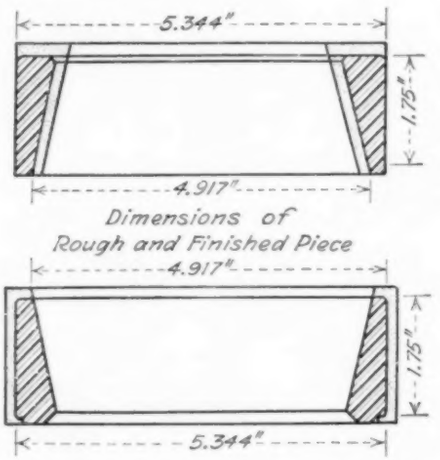
9. The secondary drive clutch engages, applying power to the work spindles and feed works and simultaneously engaging the rapid advance motion of feed works. (The upper control drum is provided with cams for both spindle drive and feed works engagement.) Control drums and shaft are now at rest.

(Functions 4 to 9 inclusive take place during one revolution of the feed drum and are performed in a total time of 3 seconds.)

10. Tool heads are rapidly advanced to a point selected for cutting feed to begin. (This is adjustable for each head.)

11. Rapid advance is disengaged and feed is engaged by trip dog adjustably mounted on feed-control ring, which is directly driven by feed drum on each head.

12. Each tool head feeds (either vertically, horizontally or in any selected angular direction) to the point of positive stop located on face of column and adjusted as required.



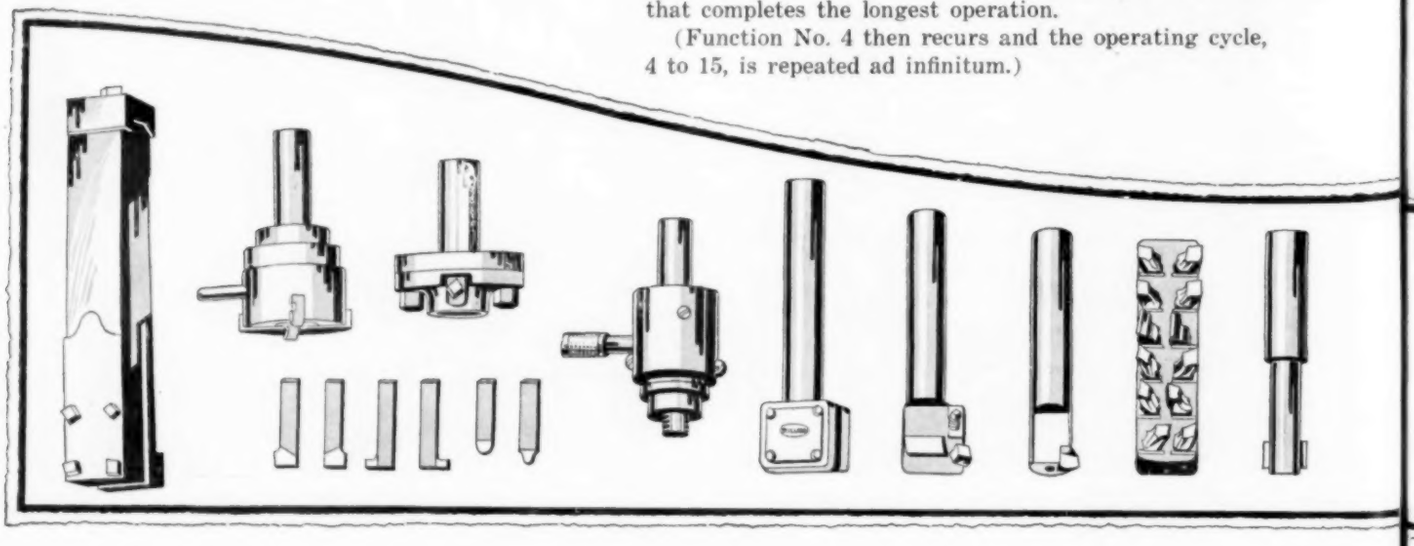
Tapered roller bearing race, finished complete ready for hardening and grinding in 112 seconds

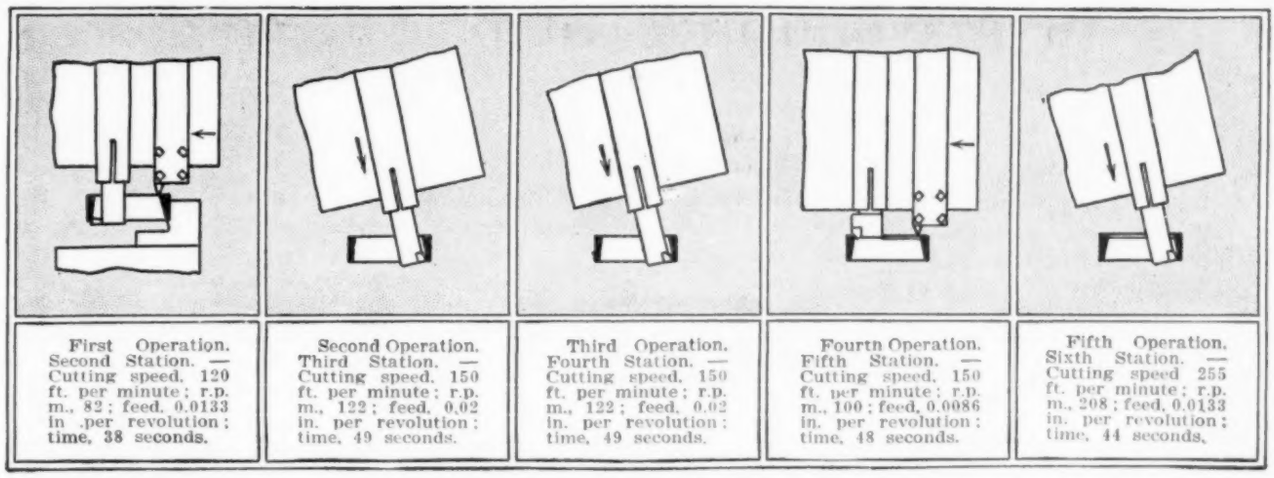
13. Tool head is rapidly returned to its initial position by a quick cam on feed drum.

14. Control-drum lock (one for each tool head) is released by dog on feed control drum, which also disengages the feed clutch.

15. Control drum is released by return of the head that completes the longest operation.

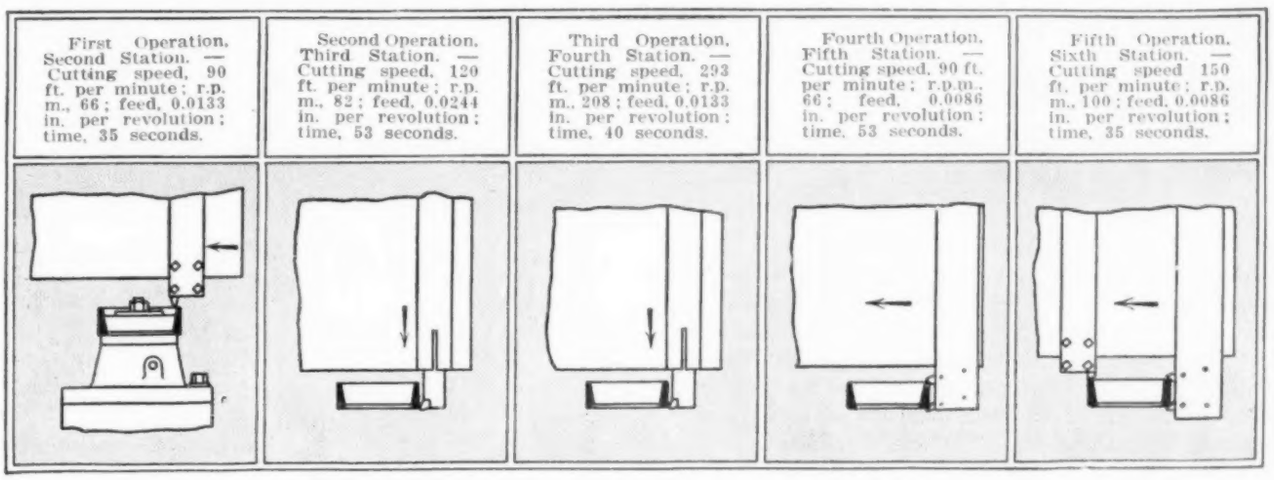
(Function No. 4 then recurs and the operating cycle, 4 to 15, is repeated ad infinitum.)





First Operation. Second Station. — Cutting speed, 120 ft. per minute; r.p. m., 82; feed, 0.0133 in. per revolution; time, 38 seconds.	Second Operation. Third Station. — Cutting speed, 150 ft. per minute; r.p. m., 122; feed, 0.02 in. per revolution; time, 49 seconds.	Third Operation. Fourth Station. — Cutting speed, 150 ft. per minute; r.p. m., 122; feed, 0.02 in. per revolution; time, 49 seconds.	Fourth Operation. Fifth Station. — Cutting speed, 150 ft. per minute; r.p. m., 100; feed, 0.0086 in. per revolution; time, 48 seconds.	Fifth Operation. Sixth Station. — Cutting speed 255 ft. per minute; r.p. m., 208; feed, 0.0133 in. per revolution; time, 44 seconds.

First chucking: Longest operation, 49 sec., index, 3 sec.; advance of tool heads 2 sec. Total, 54 seconds.

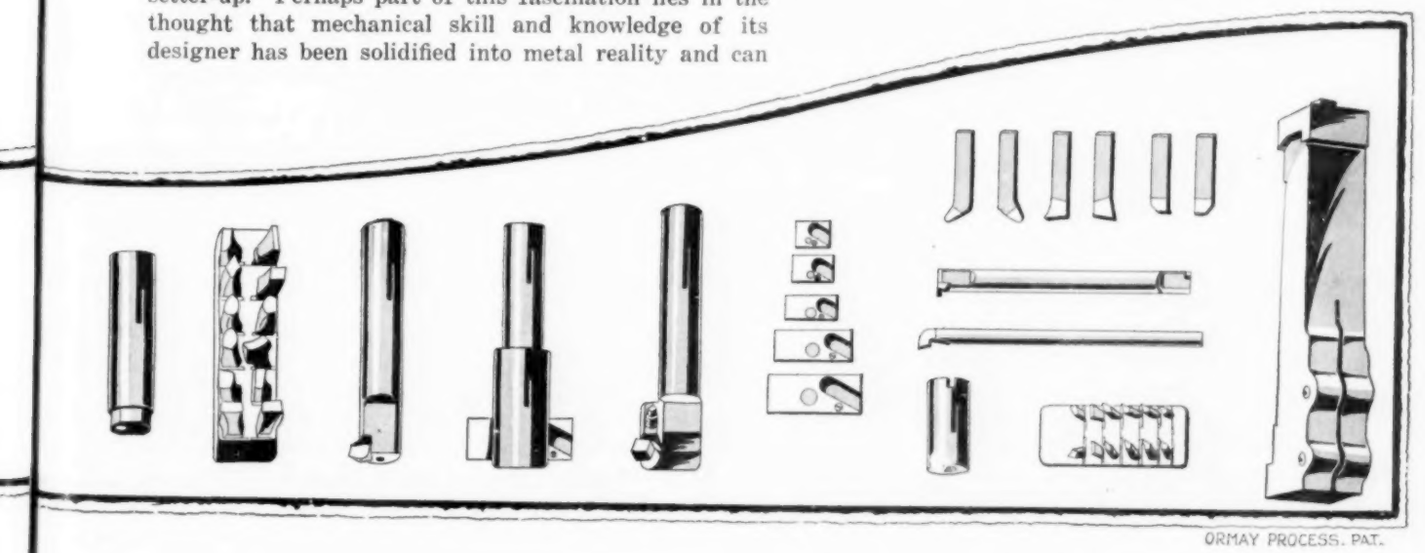


First Operation. Second Station. — Cutting speed, 90 ft. per minute; r.p. m., 66; feed, 0.0133 in. per revolution; time, 35 seconds.	Second Operation. Third Station. — Cutting speed, 120 ft. per minute; r.p. m., 82; feed, 0.0244 in. per revolution; time, 53 seconds.	Third Operation. Fourth Station. — Cutting speed, 293 ft. per minute; r.p. m., 208; feed, 0.0133 in. per revolution; time, 40 seconds.	Fourth Operation. Fifth Station. — Cutting speed, 90 ft. per minute; r.p.m., 66; feed, 0.0086 in. per revolution; time, 53 seconds.	Fifth Operation. Sixth Station. — Cutting speed 150 ft. per minute; r.p. m., 100; feed, 0.0086 in. per revolution; time, 35 seconds.

Second chucking: Longest operation, 53 sec.; index, 3 sec.; advance of tool heads, 2 sec. Total time, 58 seconds.

Fig. 6. Chart of tooling operations. Upper diagram shows operations on first chucking of tapered roller bearing race. Lower diagram shows second chucking

There is something fascinating about the operation of any automatic machine. Perhaps it lies in the demonstration of untiring faithfulness with which such a machine carries out the original instructions of its setter-up. Perhaps part of this fascination lies in the thought that mechanical skill and knowledge of its designer has been solidified into metal reality and can be put to work untiringly perpetuating this skill and knowledge. It is interesting to speculate how far automaticity can go, and this machine of the Bullards has demonstrated that it can go a long way.



An Accumulative Graphic Record

By J. B. CONWAY

SEVERAL years ago I was industrial manager of a well-known gas-engine manufacturer, and after certain changes in the method of production had been made I found it necessary to devise a chart for recording the weekly output of certain departments. Prior to this a daily record was maintained, which was totaled at the end of the week. While this served its purpose in a measure it did not portray a vivid record for comparison, and after several weeks of continuous entries the executives were compelled to work over a maze of figures in order to compare one week with the next.

To grasp quickly the essential facts the chart here reproduced was used with the exception of the several colors employed in the original. Along the left-hand margin is given in figures the required monthly output of units, which was 3300 in this instance. Each square represents 100 units, reading from bottom to top. The weekly periods are shown at the top of the chart. Heavy vertical lines divide the weekly periods into periods of four weeks.

The Weekly Output

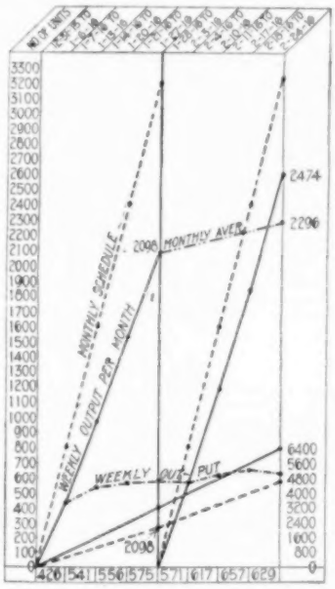
The monthly schedule is also shown by a "curve" representing the normal weekly output expected. The actual weekly output is shown for the month by the line beneath. It will be readily seen how any deviation from the normal-output curve is brought into prominence when compared in this manner. In the first month the output was only 2098, or a decrease of 1102 from the normal, which was 3200. To the foreman or superintendent responsible for getting production the figures 3200, 2098 and 1102 do not have the same significance that the gap shown on the chart between the two curves has, and they are not so readily comprehended.

Across the lower margin is entered in figures the actual number of units manufactured per week, the first week producing 426, the second 541, and so on. These figures not only amplify but verify the points on the curve for the weekly output. The curve marked "Weekly Output" is for convenience in comparing one week's output with another, and was found useful as an object lesson in talking over the results of the past week with the foremen who were more able to appreciate the fluctuations in the curve than the difference in the totals. This statement in no way casts reflections on the ability or intelligence of the foremen. If the reader has any misgivings he should himself make a few comparisons numerically.

The two curves at the bottom of the chart indicate the expected output per week for a period of two months and the actual output per week compared graphically. The scale for these curves is shown at the right-hand side of the chart extending from 0 to 6400, each square representing 800 units. Attention is called to the use of figures again to verify the points on the curve, which for the first month are 2098 and for the second month 4572, the latter being the accumulated total, or the sum of the first and second month's output. The first figure checks that represented by the curve showing the actual output per month and the latter is the sum of 2098 and 2474.

It will be noticed that a considerable gain was made during the second month over that preceding and is readily recognized by the wide divergence of the two curves for the first month and the greater parallelism of the two for the second month. This is seen at a glance in making a comparison, even though no figures were available.

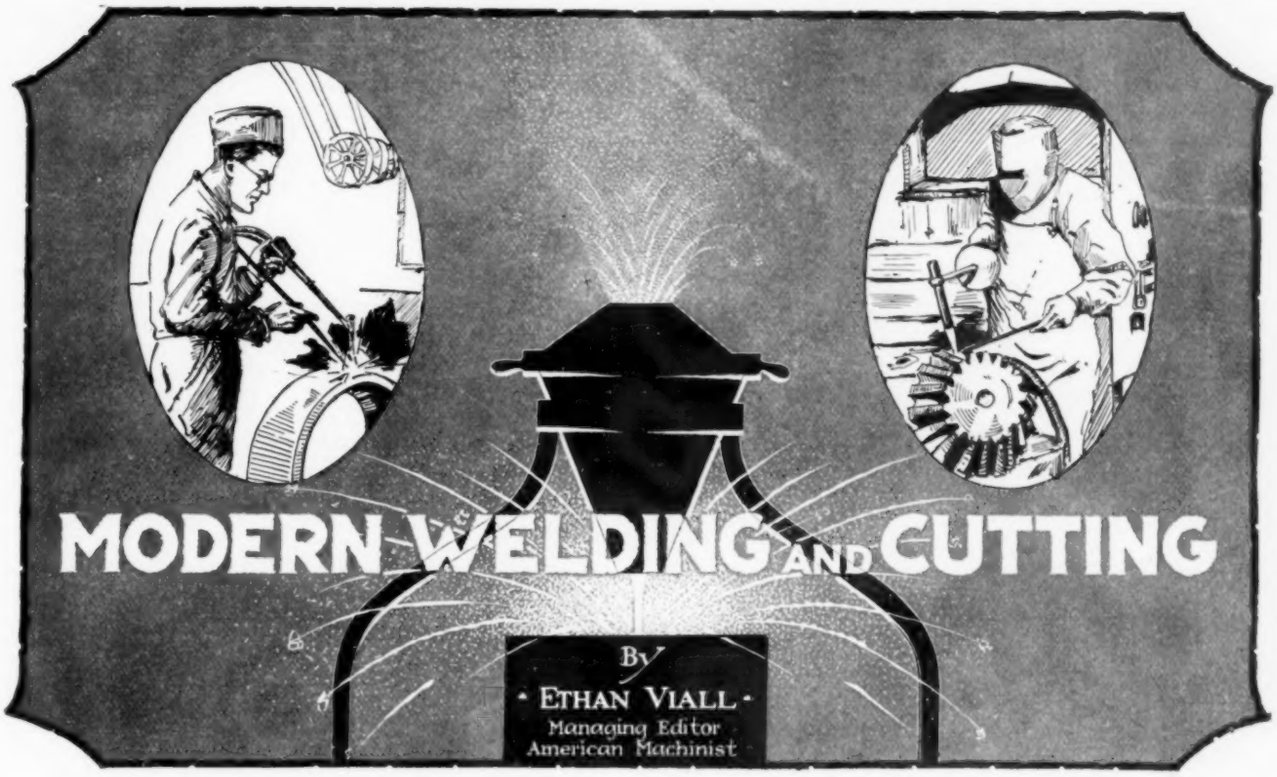
The curve starting with the end of the first month and making its path across the chart is the "Monthly Average," which is the sum of the output for the two months divided by the number of months. This, like the weekly output curve, serves as a comparison of one month's work with another. When carried for only two months as shown the curve does not show up to its best advantage, but it must be borne in mind that this entire chart carried a record for a six months' output and at the end of 12 months the two six-months' charts were fastened together, thereby giving a complete and comprehensive record for the year. In this respect the average monthly curve was an important factor of the chart. The original chart was made on quadrille paper with about five divisions to the inch. The monthly schedule was shown in red drawing ink; the weekly output in green; the weekly output per week in orange and the monthly schedule for two months with the actual output for the same period by blue lines. The average monthly curve was represented by an alternate green and orange dash. When operated in colors as described (or any other combination that may be desired) the chart has more individuality and presents a more attractive appearance.



GRAPHIC-RECORD CHART

The underlying principles of the chart may be employed to advantage for recording the units of production of almost any article, the only changes necessary being the dates and the substitution of the name of the article, if desired, for that of the "units" on the left, and the quantity required.

The chart is so arranged that the busy executive may see at a glance the condition of his business by merely observing the curves, going into details later or at his convenience. Attention is also called to the "check" introduced and mentioned previously, as this is found to be of considerable assistance in guarding against wrong entries and consequent errors in the records.



I—Thermit Welding: Its History, Nature and Uses*

This article is the first of a series intended to cover the field of modern welding and cutting in a broader way than has been previously done. The articles will pay attention to the practical rather than the theoretical side. Apparatus and equipment will be described and detailed directions given for their practical use.

THE affinity of finely powdered aluminum for oxygen, sulphur, chlorine, etc., is such that it is utilized to effect a reduction of metals from their respective oxides, sulphides and chlorides. This was known for many years and is generally credited to Frederick Wohler. About 1894 Claude Vautin found that when aluminum in a finely divided state was mixed with such compounds and ignited, an exceedingly high temperature was developed by the rapid oxidation of the aluminum. Since fine aluminum will not burn at a temperature below that of molten cast-iron Vautin and others first heated the mixtures in a crucible. The result was that the initial temperature was so high at the moment of ignition that the reaction was explosive.

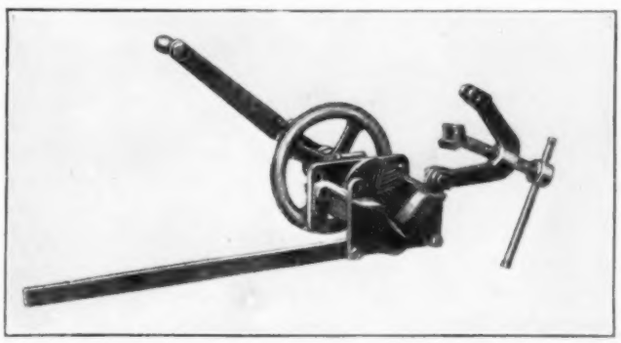


FIG. 1. PIPE-FACING MACHINE OPEN TO RECEIVE PIPE

Profiting by the experiments already made Dr. Hans Goldschmidt of Essen, Germany, discovered a method of igniting a cold mixture of fine aluminum and iron oxide by means of a barium-peroxide fuse which was set off by means of a storm match. His first discovery was made about 1895 or 1896 while trying to reduce chromium and manganese. Later magnesium powder or ribbon was used for ignition purposes, being set off in the same way. A mixture of a few pounds of the powders was found to burn quickly and the resulting temperature was very high. The original patent for the reduction of metals, upon which all his following patents were founded, was granted March 16, 1897, the serial number being 615,700. Over 40 have been issued since and more are pending. About 1898 Dr. Goldschmidt made use of his reduction method to weld two pieces of iron together. From this time on the experiments developed and difficulties were overcome until a process was evolved for the commercial use of the reaction for welding and other purposes. The process so developed was called the Thermit process. The company handling the mixtures and apparatus was originally known as the Goldschmidt Thermit Co., but in 1918 the name was changed to the Metals and Thermit Corporation, New York.

The present Thermit reaction is $8Al + 3Fe_3O_4 = 9Fe + 4Al_2O_3$. Expressed in weights this is 217 parts aluminum plus 732 parts magnetite = 540 parts steel plus 409 parts slag, or approximately 3 parts of aluminum plus 10 parts of magnetite will produce on com-

*For the author's forthcoming book, "Modern Welding and Cutting." All rights reserved.

bustion 7 parts of steel. The steel produced by the reaction represents about one-half of the original Thermit by weight and one-third by volume.

Commercial Thermit is a mixture of finely divided aluminum and less finely divided magnetic iron scale. The aluminum is about like granulated sugar and the scale like coarse sand, the ratio by weight being approximately three of iron scale to one of aluminum.

According to the company just mentioned the average analysis of Thermit steel is:

	Per Cent.
Carbon	0.05 to 0.10
Manganese	0.08 to 0.10
Silicon	0.09 to 0.20
Sulphur	0.03 to 0.04
Phosphorus	0.04 to 0.05
Aluminum	0.07 to 0.18

Of course to produce a steel of the foregoing composition the aluminum and iron scale must be very pure. For the mixture, scale from Bessemer or open-hearth steel would probably come close to meeting commercial demands. The average tensile strength of a Thermit weld of the foregoing average composition is about 61,000 lb. per square inch. This can be varied by adding other elements. The elastic limit is slightly more than half this figure, or an average of about 34,000 pounds.

Temperature and Characteristics

While the temperature of the reaction is too high to be measured by a pyrometer it can be calculated quite accurately theoretically and Prof. Joseph W. Richards in his book "Metallurgical Calculations," gives it as 2694 deg. C., which is equal to 4881 deg. F. M. Féry, using his radiation pyrometer, found the temperature of the stream of steel as it issued from the crucible to be 2300 deg. C. (4172 F.). Making allowance for the chilling effect of the crucible this is probably about right. Considering the melting point of steel to be about 1350 deg. C. Thermit steel is nearly twice as hot.

There is absolutely nothing explosive about the present Thermit reaction and no danger is incurred in storing it or handling the material owing to the fact that it takes over 1300 deg. C. of heat to ignite it. It is for this reason that a special ignition powder must be used for starting the reaction. The ignition powder, however, must be kept away from heat, and in particular the box containing it should be tightly closed before the Thermit reaction takes place, so as to prevent any spark from dropping into it. All Thermit materials must be kept dry, for Thermit that has once become wet cannot be restored to its original condition by drying.

There are two different methods of using Thermit for welding purposes. For convenience these methods may be designated (1) the plastic method and (2) the fusion method. The first is used principally for welding together the ends of pipes. Here the pipe ends are first machined off so that they will fit snugly together. A mold is then placed around the ends, and Thermit is poured into the mold from a crucible. The Thermit mixture is first placed in the crucible and ignited by means of a small amount of ignition powder set off by a match.

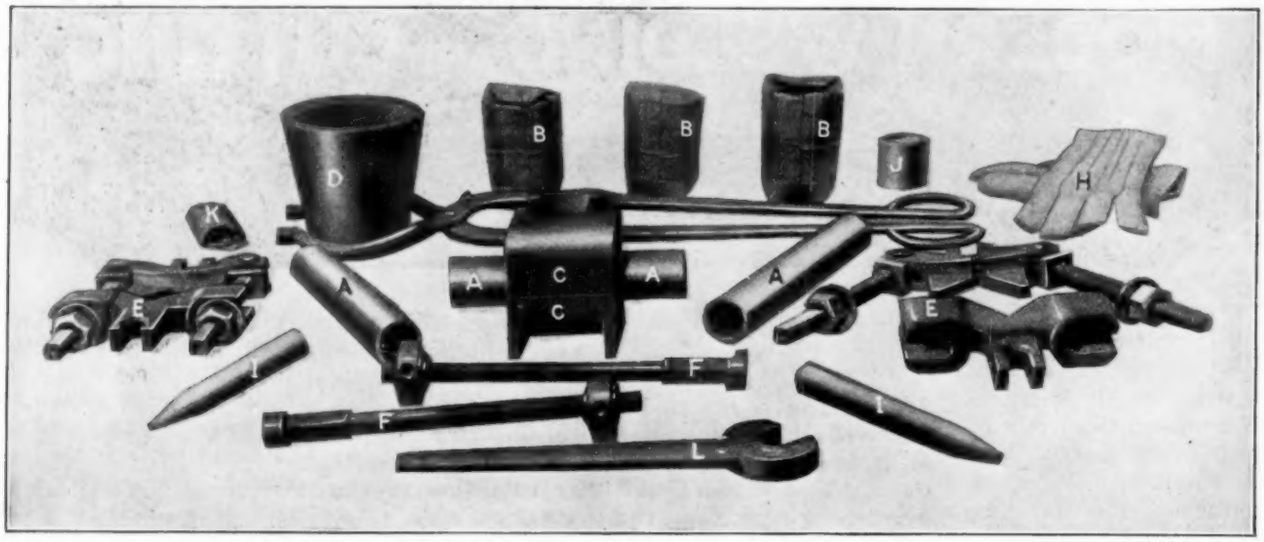


FIG. 2 MATERIALS FOR WELDING PIPE

After the reaction the molten content of the crucible is poured into the mold and around the pipe ends. By pouring from the top of the crucible the slag enters the mold first and surrounds and coats the pipe ends and the inside of the mold and thus prevents the pipe ends from being burned through. This allows the Thermit to heat the pipe ends to a welding heat, after which they are forced together, causing a slightly upset welded joint.

The second, or fusion method, is the more commonly used. In using this method a mold is also used to surround the parts to be welded, but the parts must be preheated—usually to a red heat—in order to prevent the Thermit being chilled by contact with the colder metal and causing an imperfect weld. The Thermit to be used is placed in a cone-shaped crucible so made that the melted Thermit steel may be run out of the bottom into the mold, thus preventing the slag from getting into the mold and spoiling the perfect fusion of the parts. In this method it is also necessary to have the parts to be welded some distance apart in order to give the Thermit steel an opportunity to properly fuse the surfaces desired and produce a perfect union. The distance the parts are separated depends on the size and nature of the pieces and whether the weld is to be made on two separate pieces or is merely to weld a cracked place.

This last method is especially adapted for welding

together large heavy parts of considerable section, on account of the Thermit steel being produced and introduced into the weld quickly in bulk and thereby resulting in but one contraction throughout the entire mass of metal. Provision to compensate for this contraction can always be made, so that when the metal cools there will exist practically no strains. Welds requiring as high as 4000 lb. or more of Thermit have been completed successfully. A big advantage of the process is that huge welds may often be made without dismantling the machine or structure, thus saving an enormous amount of labor and time in many cases.

Neither method, however, is commercially or practically adapted to welding very small sections or long seams in thin sections, which work can be better accomplished by the oxyacetylene or electric welding processes. It should, however, be used for welding shafts no matter how small when the break is in a journal. It is interesting to note in this connection that neither the oxyacetylene nor the electric welding process has proved practical for welding trolley rails together. All so-called welded joints by those methods consist merely in welding plates to the rails and the joint therefore is never really eliminated. The Thermit process, on the other hand, has proved extremely efficient and economical for this work, and thousands of Thermit-welded rail joints have been in service for years in all parts of the world.

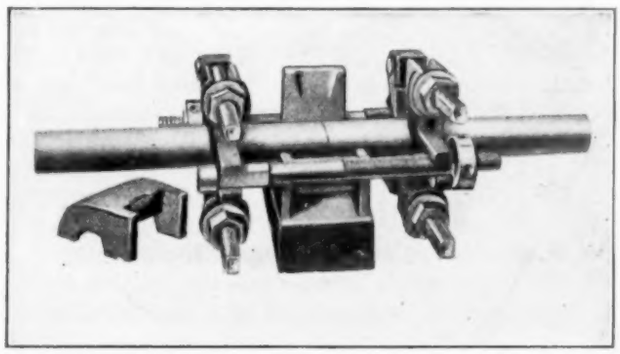


FIG. 3. PIPE HELD IN CLAMPS, MOLD PARTLY ASSEMBLED

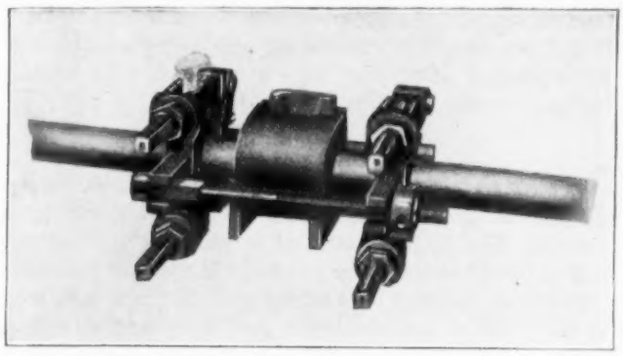


FIG. 4. MOLD FULLY ASSEMBLED FOR WELD

Kinds of Thermit Commonly Used

For commercial welding purposes there are now produced three varieties of Thermit known as:

Plain Thermit.
Railroad Thermit.
Cast-iron Thermit.

Plain Thermit is simply a mixture of aluminum and iron oxide, as previously stated, and is used in making pipe welds and welding necks on mill rolls and pinions where the Thermit is merely used as a heating agent to bring the pipe ends up to a welding temperature and the roll and pinion ends to a molten state.

Railroad Thermit is plain Thermit with the addition of ⅜ per cent. nickel, 1 per cent. manganese and 15 per cent mild-steel punchings. This grade is used in connection with steel welds.

Cast-iron Thermit is plain Thermit with the addition of 3 per cent. ferrosilicon and 20 per cent. mild-steel punchings, and is used, as its name implies, for welding cast-iron parts.

Taking up now the various uses of the three varieties of commercial Thermit we will first describe in detail the butt welding of pipe. This process is especially adapted to welding joints in the pipes in refrigerating plants and for high-pressure steam, hydraulic or compressed-air pipe lines. It is also applicable to the welding of superheater units for locomotives. The joints so welded are permanent, nonleakable and never require attention, and the original cost compares very favorably with that of the special mechanical joints of any type used for refrigerating or high-pressure purposes. All of the apparatus necessary for the work is easily portable, so that the work may be done anywhere.

In preparing pipe for butt welding it is first necessary to insure that the ends are cut square. If the pipe is threaded the threaded portions will have to be cut off. While the ends of the pipe may of course be squared by various mechanical means the company handling Thermit makes a small portable machine for the purpose, which is much more satisfactory to use than anything else. This device is shown in Fig. 1. The operation of this machine is so obvious to any mechanic that further explanation of its operation and method of use would be needless, except to say that the crank handle by which the cutter is rotated has a ratchet on it so that the cutter may be worked in close quarters.

If after the pipe ends have been faced off they should become tarnished they should be brightened with clean, fine emery cloth or a flat carborundum stone, but in no case should the faced ends be touched with a file or the fingers.

When the pipe ends have been properly faced off, the pipe is lined up so that the faced ends will butt squarely together and then the mold is put in place. In welding coils or bends suitable apparatus should be rigged up to keep the pipe in alignment. Where the pipes are close together in coils it is usually possible to spring out the pipe to be welded so as to permit the adjustment of the mold and clamps.

A Pipe-Welding Outfit

A complete outfit for welding pipe, less the facing machine, is shown in Fig. 2. In this cut, pieces of pipe are shown at *A;* welding portions of Thermit at *B;* cast-iron mold at *C;* at *D* is the magnesia-lined crucible; *E*, clamps; *F*, turnbuckles for clamps; *G*, crucible tongs; *H*, gloves; *I*, pins for tightening turnbuckle nuts; *J*, ignition powder; *K*, dark glasses, and *L*, wrench for tightening nuts of clamps. In order to make the procedure clearer a pipe-mold and clamp unit is shown in Fig. 3. Here the pipe is shown securely clamped in place

with the ends butting together. When putting this apparatus in place the clamps are first adjusted at an even distance from the ends of the pipe and securely clamped. The two tension bolts are then adjusted so as to bring an even bearing all around on the pipe ends,

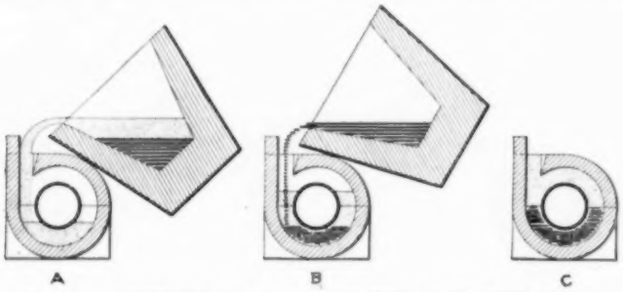


FIG. 5. POURING SLAG AND STEEL INTO THE MOLD

but care must be taken not to put such a tension on the pipe that it will buckle when heated. Just enough tension to hold the ends securely is all that is needed. It will be seen that while a set of clamps may be used for a number of sizes of pipe a mold can only be used for the size for which it was made.

How the Mold Is Used

The lower part of the mold is shown in place, but the top part of the mold is shown at the left ready to be put on. The slightly beveled recesses in the top and bottom parts of the mold are for the pouring gate. Before putting the top part of the mold in place care must be taken to see that the lower part is blocked up or held so as to be in close contact with the pipe. This may be done by means of wedges, earth or any other means at hand that will stay in place during the process. With the top part of the mold in place, as shown in Fig. 4, the operator next prepares the Thermit for pouring. This is done by placing the crucible tongs on the ground convenient to the mold and then setting the crucible in the jaws of the tongs. It is very important that the crucible be thoroughly dried before using, and if it is a new crucible it is advisable to burn a pound or so of Thermit in it and then pour the contents out on dry sand. This is the quickest and most convenient way of drying a crucible. The operator should have the handles of the tongs placed toward him convenient for pouring the metal when the reaction is completed. If double tongs are used, as sometimes is necessary with large crucibles, the helper should stand opposite the operator in readiness to help pick up the crucible at the proper time. Blue or special glasses should be worn to protect the eyes from the glare of the reaction.

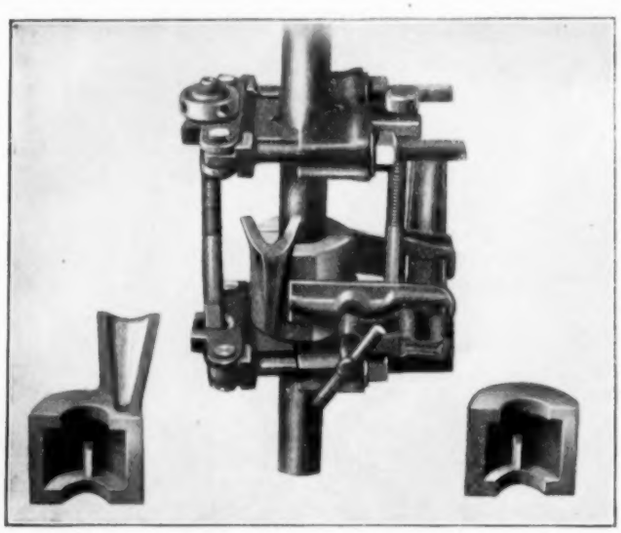


FIG. 6. MOLD FOR WELDING VERTICAL PIPE

As each size of pipe must have its own size of mold so must the portions of Thermit be measured out in order to have the proper amount for a given size of pipe. This is taken care of by the concern making the Thermit, which puts it into bags, each containing a certain amount of Thermit suitable for a given welding job. For all ordinary jobs this scheme makes it unnecessary for the operator to do any special calculating in order to know how much to use in order to do the work and not waste material.

Placing and Igniting the Thermit

With a bag containing the proper amount of Thermit the operator pours about one-half into the crucible and the rest in a hand scoop for feeding into the crucible during the reaction. Having therefore one part of this portion in the crucible and the remainder in a scoop he places a half spoonful of ignition powder (barium peroxide) in one spot on top of the Thermit in the crucible. This is set off by means of a parlor match, which is applied immediately after striking and before the head is burned off, to the ignition powder itself or else to another match head set into the ignition powder.

The ignition of the powder in turn starts the Thermit reaction. After the reaction is well started the operator adds the rest of the Thermit from the scoop, trying to keep about one-half of the surface of the molten material covered with unburned Thermit, and pouring in a steady stream until all the Thermit is in the crucible. He should then immediately grasp the crucible with the tongs, obtaining a firm grip, and pour the contents into the mold, the slag entering first. The pour should be made as soon as the Thermit has reacted and the slag has come to the top. The crucible and tongs are then set aside and a short time is allowed to elapse for the Thermit mass to bring the ends of the pipe to a welding heat. Shortly after pouring the operator should turn the tension nuts enough to keep a constant pressure to determine when the pipe begins to soften. He should then wait for 10 to 20 sec., depending on the weight of pipe, and then force the ends together by means of four quarter turns (one complete revolution) of the nuts. It usually takes about 10 sec. from the time the pipe softens for it to reach a welding heat, or from 45 sec. to 1½ min. from the time of pouring.

Removing the Mold

After the clamps have been drawn up, the mold should be allowed to remain in place for 3 or 4 min. longer, after which the clamps can be removed and the cast-iron mold knocked away from the pipe by means of a hammer. The Thermit steel and slag will come away from the pipe with the mold and can be knocked out of the mold afterward.

Care must be taken in every case that a complete welding portion be used, as only the full measure of Thermit will give a good weld.

It is advisable where joints are being welded in quan-

tities to have several molds so as not to use molds continuously while hot. It is also advantageous to allow the mold with its contents of steel and slag to remain on the pipe for a considerable time before removing. If they can be left 10 to 15 min. it is all the better.

It has been found in practice that two men, one facing the pipe with the pipe-facing machine and the other doing the welding, can complete a weld inside of 10 min. and that it is a simple matter for them to make from 40 to 50 finished pipe welds a day.

It must be understood from the foregoing that the slag that forms on top of the molten material in the crucible is poured into the mold first. As soon as this slag strikes the cold pipe and inner surface of the mold it forms a protective coating which prevents the superheated liquid steel which flows in after it from coming in direct contact with either the pipe or the mold. The heat of the entire mass, however, serves to bring the pipe ends to the desired temperature. The method of pouring will be understood from Fig. 5. In this cut *A* shows the slag flowing into the mold and coating the pipe and inside of the mold; *B* shows the slag in the mold and the steel following, displacing the slag in the bottom part of the mold, and *C* shows the mold about half full of steel, but a film of slag separating it from the pipe and mold.

TABLE I.—COMPARATIVE COSTS OF MECHANICAL AND THERMIT JOINTS, TAKEN FROM "REACTIONS" FOR THE FIRST QUARTER OF 1918, WITH THERMIT FIGURED AT 35 CENTS PER POUND

Size of Pipe, Inches	Average Net Cost Square Arm Flanges with Bolts and Gaskets	Average Net Price Installing and Sweating on Pipe	Total Cost of Installation	Cost of Materials for Thermit Weld	Labor per Joint One Man at 30c per Hour	Total Cost Thermit Weld per Joint
½	$1 01	$0 18	$1.19	$0 24	$0 10	$0.34
1	1 13	0 18	1.31	0 44	0 10	0.54
1¼	1 45	0 24	1.69	0 65	0 10	0.75
1½	1 51	0 30	1.81	0 80	0 10	0.90
2	1 67	0 42	2.09	0 95	0 10	1.05
2½	3 15	0 60	3.75	1 44	0 125	1.57
3	4 16	0 90	5.06	2 33	0 15	2.48
3½	4 47	1 20	5.67	3 06	0 15	3.21
4	5 35	1 20	6.55	4 60	0 175	4.78

The above costs for mechanical joints are based on standard list prices less a 37 per cent. discount.

The foregoing instructions apply to welding pipe in a horizontal position. Vertical pipe, however, can be welded in essentially the same manner, but a special mold is required. This mold is constructed in such a way as to divide the Thermit-steel collar into two parts, so that it may be readily removed from the pipe on the completion of the weld. The mold also has a different type of pouring gate, as will be seen in Fig. 6.

The same method used for welding pipe may be used for welding bars or rods of mild steel or wrought iron of various sizes and shapes, but this method is not applicable to welding cast iron or high-carbon steel. For the latter work another method must be used.

It may be of interest to compare the cost of a Thermit-welded joint with that of mechanically coupled pipe, and for this the reader is referred to Table I, which was taken from *Reactions*, which is the house organ of the Metal and Thermit Corporation. While accurate determination of the cost that will cover general practice is always difficult there is no doubt about the superiority from every standpoint of the Thermit-welded joint where a solid, leak-proof and especially strong coupling is wanted. For ammonia-pipe or similar installations the solid joint is one that every real engineer will recommend.

As to the comparative strength of a Thermit-welded pipe joint the following is taken from a report made by Prof. Frederick L. Pryor of Stevens Institute July 10, 1914:

"Two classes of pipe, standard weight and extra heavy, were tested, the sizes selected for each type being 1 in. and 1¼ in. Six samples each of 1-in. standard, 1-in. extra heavy, 1¼-in. standard and 1¼-in. extra heavy were selected for test, three being used for the bursting test and three for the tensile test. One specimen was left in its original form and two specimens were cut in half and joined together, one with a Thermit weld and one with standard-threaded couplings. One specimen of each size and type was subjected to tensile and bursting tests. Standard-weight couplings were used for standard pipe and extra heavy couplings for extra heavy pipe, and the welded specimens were put together by your process. The thickness of the material at the weld was afterward determined and found to be about 0.02 in. more than the thickness of the pipe for the 1-in. specimens, and about 0.075 in. more than the thickness of the pipe for the 1¼-in. specimens. A number of pieces of pipe were measured to check the thickness with the accepted standard and each specimen was within the tolerance factor.

"The tension tests were made in the usual manner, except that a plug was inserted in each end of the pipe in order to assist the gripping action in the machine.

"The bursting test was made by pumping oil into the pipe under pressure, the actual pressure to force the plug into the cylinder being determined by the dimensions of the pressure plug and the weight on the scale beam.

"In the tension tests all the pipes joined by couplings ruptured in the root of the thread at the coupling, and the welded samples ruptured away from the weld with one exception.

"In the bursting tests all samples, including those put together by couplings and welds, ruptured in the seam of pipe. The location of the ruptures for both the tension and bursting tests are noted in Table II."

Professor Pryor also at about the same time made some vibratory tests. The pipe selected was 1¼-in. extra heavy, and each test piece was composed of 6-ft. lengths joined together by the coupling or weld. The

Thermit welds were made in the presence of Professor Pryor by a representative of the Thermit company and were regular standard Thermit joints. These 12-ft. pieces with a joint in the center were subjected to a vibratory motion, the pipe depressed and raised 2 in. below and above the center line. The test pipe was filled with water under 22 lb. pressure in order to show the first failure of the material. Two tests were made of the pipe joined with extra heavy screwed coupling and one test of the welded joint pipe. The reason only one test was made on the Thermit-welded pipe was that the number of deflections on it was about 250 times the deflections made on the screwed coupling, with no sign of any deleterious effect. Both the screwed-joint specimens broke just outside the coupling in the root of the thread under 6160 and 3430 vibrations respectively. The Thermit specimen was vibrated 1,566,340 times, after which it was removed from the test and at the time no injury was apparent. The speed of these vibrations was about 225 vibrations per minute.

TABLE II.—RESULTS OF TENSION AND BURSTING TESTS ON SCREW-COUPLED AND THERMIT-WELDED PIPE JOINTS

	DIMENSIONS IN INCHES		
	Outside Diameter	Inside Diameter	Thickness
1″ standard	1.315	1.049	.133
1¼″ standard	1.660	1.380	.140
1″ extra heavy	1.315	.951	.182
1¼″ extra heavy	1.660	1.272	.194

Character of Pipe	Yield Point, (Actual), Lbs.	Ultimate Tensile Strength, (Actual), Lbs.	Approximate Location of Rupture	Bursting Pressure, Lbs. Sq. In.	Approximate Location of Rupture
1″ Standard					
Straight	18,000	27,900	Between grips	11,580	Center of pipe
Coupling	17,250	20,320	Root of thread at coupling	9,260	6″ from coupling
Welded	16,500	26,130	2½″ from weld	10,560	4″ from weld
1″ Extra Heavy					
Straight	19,200	34,730	Between grips	13,510	2″ from end of pipe
Coupling	.....	18,770	Root of thread at coupling	13,310	3″ from end of pipe
Welded	23,000	34,970	8″ from weld	14,220	2″ from end of pipe
1¼″ Standard					
Straight	22,300	37,670	Between grips	9,440	7″ from end of pipe
Coupling	21,380	28,500	Root of thread at coupling	8,050	7″ from end of pipe
Welded	20,930	36,020	At weld	8,460	1½″ from end of pipe
1¼″ Extra Heavy					
Straight	29,380	50,620	Between grips	12,900	1½″ from end of pipe
Coupling	29,100	29,100	Root of thread at coupling	12,770	2″ from end of pipe
Welded	27,800	50,980	6″ from weld	11,490	1″ from end of pipe

Draftsman or Engineer?

By E. W. Weaver

Mechanical drawing is the written language of engineering and is directly analogous to the written-word language. It might be possible for a man to be a real engineer without being able to read or write the language, just as a person might be an author without being able to read or write.

There are varying degrees of proficiency in the use of language. To adhere to the comparison: (1) The beginner learns to read and write. (2) Later stenography may be taken up, learning to take down the expressions of another and type them out in presentable manner. (3) In case special ability is shown, the stenographer may be trusted to frame the general form and expression of the letter, but the general intent is settled by another. (4) Next comes the ability to think thoughts that are worth writing down. (5) It is not absolutely necessary for the individual to pass through all of the preceding stages in order to arrive at the fourth; a few exceptional ones may skip them all and land themselves successfully in this latter class, but the chances are very much against such an accomplishment, and as a matter of fact it is quite as unusual to find a really competent engineer who cannot read and write the language of his profession as it is to find a good author who is unfamiliar with English. (6) The ability to convince someone who has need of his services that the thoughts and ideas evolved are worth setting forth on paper and paying for either in money, publicity or other valuable perquisites. In engineering work there is such a gradual shading off in degree of skill, knowledge and accomplishment that it is practically impossible to draw a definite line of demarcation to denote where the draftsman class ends and that of the engineer begins. My own method of reaching this decision would be to place in the engineer class all those individuals competent to make the proper decisions in matters involving practical matters of a technical nature and capable of rendering sound judgment thereon. It may be that the nature of the work is such that he works over the drawing board, just as some authors type their own essays. A good many employers and executives take a narrow view and do not give their men the recognition they deserve. They feel that if they call a man an engineer they ought to pay him more than they do when they call him a draftsman. On the other hand a good many engineers feel that it is beneath their dignity to operate a T-square and triangle.

Engineering schools are run for the purpose of turning out engineers, not draftsmen, and there is a natural desire on the part of the graduate to feel that the time and effort he has spent on his course have made him an engineer. As a matter of fact he may have the sound judgment that entitles him at once to the rank of engineer, while on the other hand he may never get it and will never deserve a rank above that of draftsman. The knowledge and judgment one has, together with a certain amount of ability to convince others that he has them, are not dependent on the possession of a B.S. or an M.E. degree, some of the best engineers never having seen the inside of an engineering school

How the 155-Mm. Howitzer Is Made—V

By J. V. HUNTER
Western Editor *American Machinist*

The breech of this howitzer contains approximately 96 distinct parts, all of which require a high degree of manufacturing ability to insure accuracy of production. Many of the more important parts of this intricate and interesting mechanism are shown in the illustration accompanying this article, and the operations involved in the manufacture are described.

RAPIDITY of fire and ease of handling most field guns depend upon the design and execution of the mechanical details of the breech mechanism. A good idea of the general appearance of the closed breech may be obtained from Fig. 87. In this view the firing-mechanism housing which carries the primer is in place and the percussion hammer is in position ready for striking.

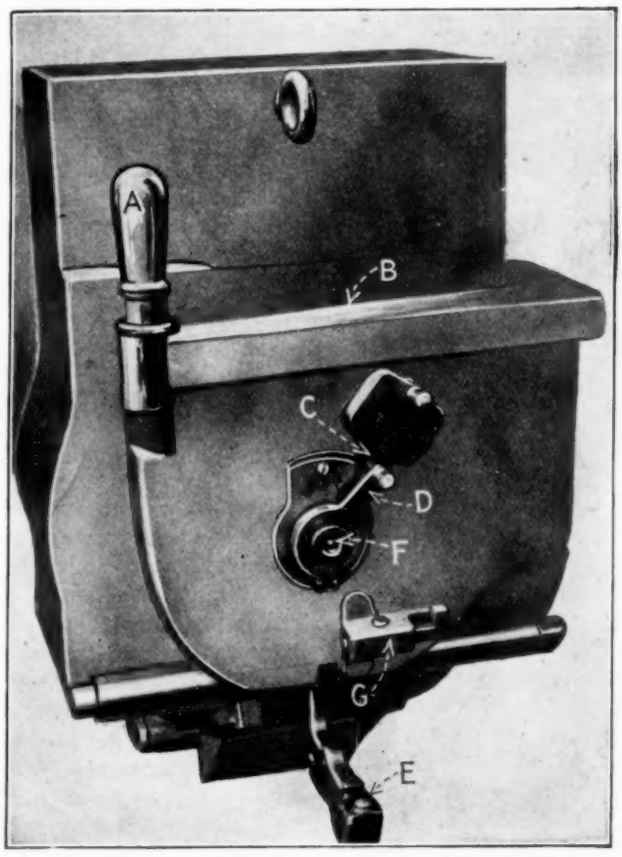


FIG. 87. VIEW OF GUN WITH BREECH CLOSED

To open the breech the handle *A* is pressed downward; this action trips the operating-lever latch, which is housed inside of the lever *B*. The handle and lever are then swung to the right and in so doing their first action is to operate the rack inside of the block carrier, which gives the breech block a 45-deg. turn, disengaging its thread sectors from the corresponding thread sectors within the breech. Further swinging of the operating lever carries the breech block open and clear of the line of opening of the cartridge chamber to permit the introduction of the cartridge.

When the breech block has thus been swung open to its furthest point, as indicated in Fig. 88, the operating-lever latch locks and holds it in that position. This prevents any tendency toward closing during loading when the gun may be depressed at an angle of 20 deg. or more. In closing the breech the latch is tripped by the same downward motion of the handle.

The Firing-Mechanism Housing

The firing-mechanism housing, which may be seen hanging on the eyebolt at *A*, Fig. 88, is in place in the breech block in Fig. 87. The latch *C* catches the handle *D* of this mechanism and prevents danger of partial disengagement during firing. During transportation of the gun the hammer *E* is raised up against the firing pin *F* and held in that position by the latch *G*.

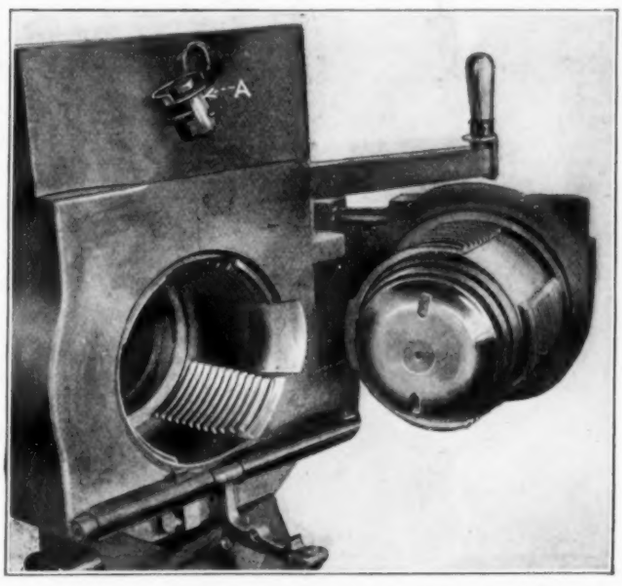


FIG. 88. INTERIOR OF GUN AND BREECH BLOCK

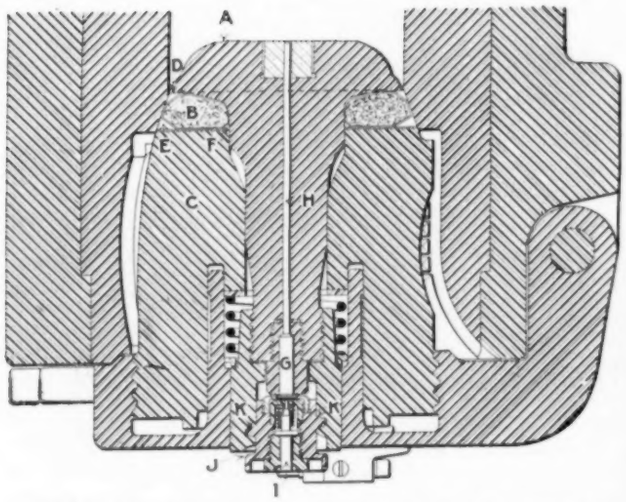


FIG. 89. HORIZONTAL SECTION THROUGH BREECH MECHANISM

A horizontal section through the breech mechanism is shown in Fig. 89. The obturator spindle *A* takes the direct thrust of the firing charge. In receiving this thrust it exerts pressure upon the gas-check pad *B*, forcing it to expand against the gas-check seat and sealing the breech against any backward escape of the gases. Three steel rings *D*, *E* and *F* aid in distributing the compression on the gas-check pad and forcing it to expand in the proper direction. The breech block is the part *C*.

Placing the Primer

The primer cartridge is placed in the position *G* and on discharge fires through the vent hole *H* in the obturator spindle. The firing pin is shown at *I*, and is held in the housing *J*. The threads by which the firing-pin housing is screwed into the breech block are shown in section at *K*.

The breech-block carrier *A*, Fig. 90, is swung from the hinged pin *B*. This hinged pin is held in place by the collar *C* and detent pin *D*. In case of emergency, such as abandoning the gun, the detent pin can be pulled out and the collar and hinge pin instantly removed, permitting the breech mechanism to be lifted off and carried away, thus rendering the gun useless to the enemy.

FIG. 96. HEAT-TREATING FURNACES AND SOME OF THE QUENCHING TANKS

At *E* is the rack shown in mesh with the toothed section of the breech block.

Rack Block Explained

The rack block is shown in the section at *G*. When this functions to lock the rack its spring *H* forces it upward and to the right, as viewed in the side elevation, and allows it to project beyond the inner face of the breech-block carrier. When the breech block is closed, the inner face of the carrier comes in contact with the breech end of the gun, and the rack lock *G* is forced back into its recess, releasing the rack, which is then free to rotate the breech block.

The larger parts used in the assembling of the gun and breech mechanism are shown in Fig. 91, in which *A* is the bridle, *B* the counterweight, *C* the gas-check pad, *D* the breech block and *E* the obturator spindle.

Fig. 92 shows three views of the breech-block carrier and indicates to some extent the amount of machine work required in its production.

Other parts used in connection with the breech mechanism are illustrated in Fig. 93. *A* is the percussion-hammer assembly, including the operating shaft and lock bolt, and *B* the firing-mechanism housing ready

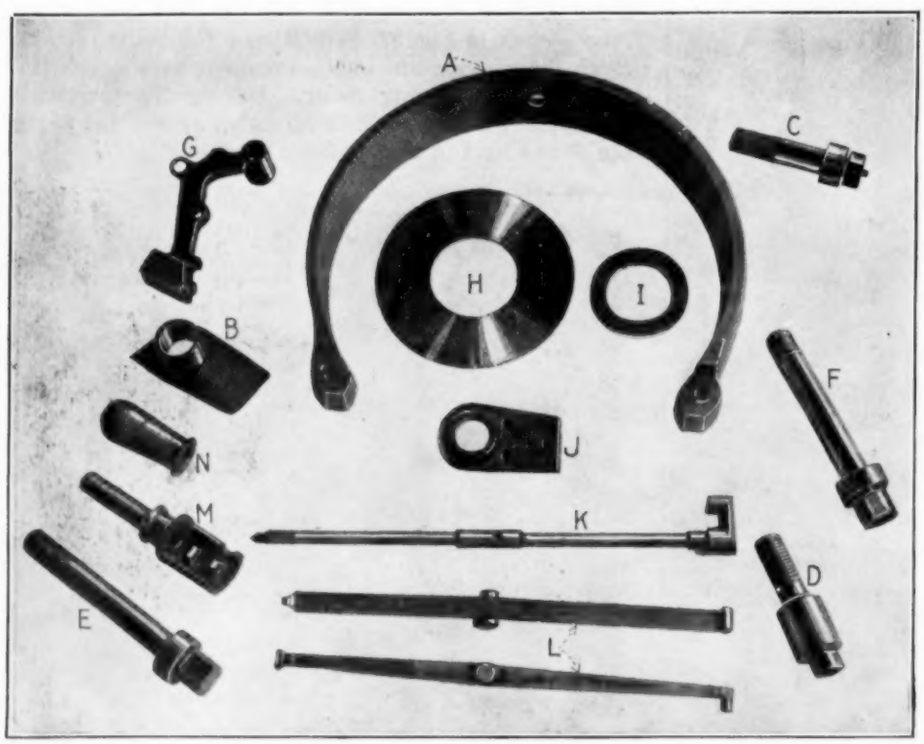


FIG. 94. HOLDING-DOWN BAND, HAMMER SHAFT, OPERATING-LEVER LATCH AND VARIOUS OTHER PARTS

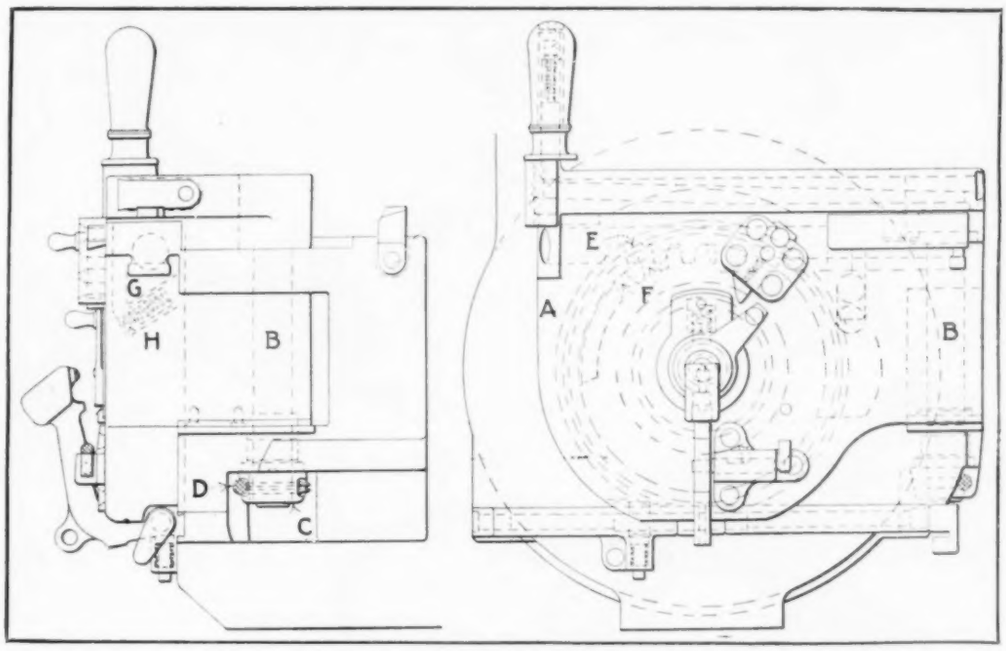


FIG. 90. DETAILS OF THE BREECH AND OPERATING MECHANISM

to receive the firing-mechanism block *C*. *D* is the firing-mechanism block latch; *E* the percussion-hammer lock bolt; *G* the equalizing rings for the gas-check pad; *H* the operating lever, and *I* the rack.

Another group of the larger parts required for the breech-mechanism assembly is illustrated in Fig. 94. Some of the parts shown are used on the gun body and do not belong to the breech mechanism. Of these the largest part *A* is the holding-down band used for retaining the gun body on its carriage. The regulating plate *B* goes on the hinged recess section of the breech end of the gun to take up the wear from the swinging of the hinge section of the block carrier. The screws *C*, *D*, *E* and *F* are used for attaching the bridle block and the counterweight to the gun body.

Details of Breech Mechanism

Of the parts that belong to the breech mechanism *G* is the percussion hammer; *H* the filling-in disk; *I* the spindle spring, front seat; *J* the block carrier-hinge bearing plate; *K* the percussion-hammer operating shaft; *L* the operating-lever latch; *M* the operating-lever handle, and *N* the operating-lever handle sleeve. Practically all of the smaller parts used in the assembly of the breech mechanism are in Fig. 95.

As has been explained elsewhere the tube and the jacket receive their heat treatment at the forging plant before they are shipped to the gun plant. The remainder of the forgings, which are all practically portions of the breech mechanism, is shipped to the gun plant in the rough and without heat treatment. They receive the necessary heat treatment either before or after machining as the specifications require. A complete heat-treating department has been installed at the gun plant and a small part of the equipment is shown in Fig. 96. The furnaces shown are for heat treatment only. On the opposite side of the room are the furnaces used for case hardening, and in the foreground are the quenching tanks.

After heat treatment every part is subjected to Brinell hardness test both by the gun plant and by the Government inspectors.

Heat Treatment

The specifications for the heat treatment of the various parts of the breech mechanism are very thorough and extensive. Each part must receive almost individual treatment. By that is meant that no batch of miscellaneous mixed parts can be put into the furnace at one time. A number of different grades and classes

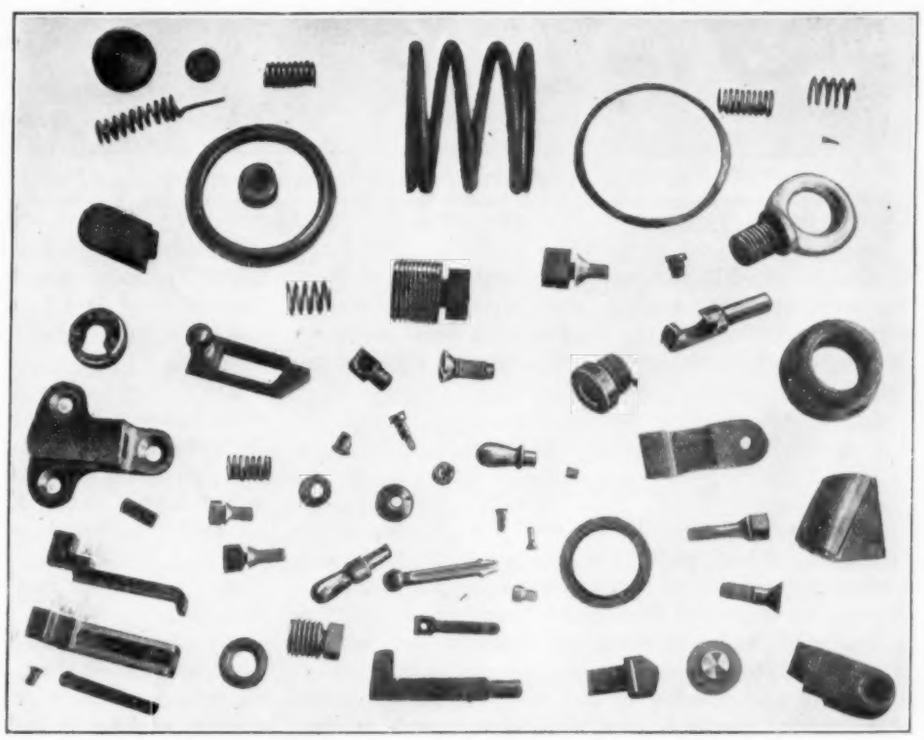
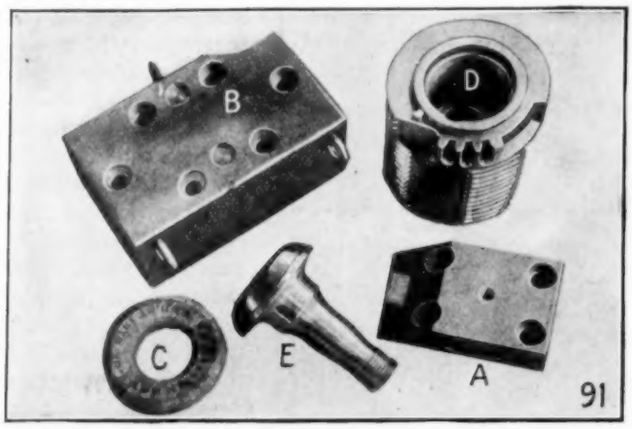
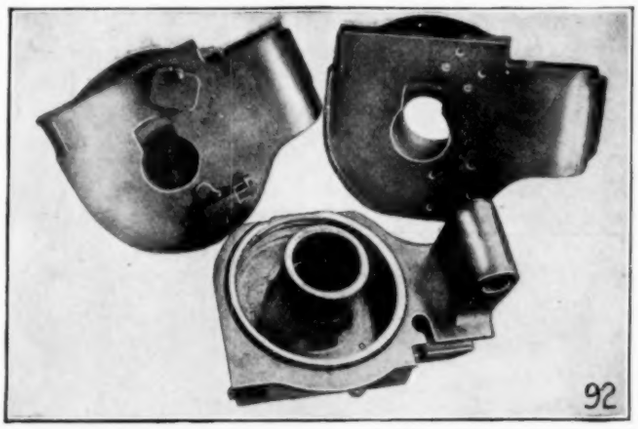
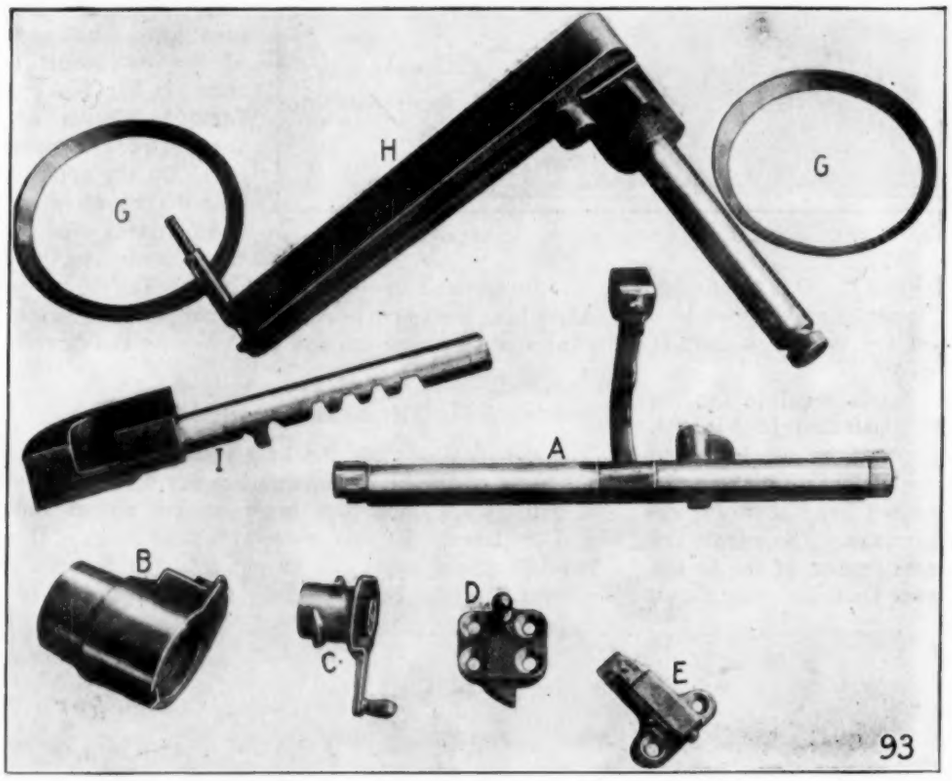


FIG. 95. SMALL PARTS USED IN ASSEMBLY OF BREECH MECHANISM







FIGS. 91 TO 93. OPERATING PARTS OF THE HOWITZER

Fig. 91—Counterweight, bridle block, breech block and spindle parts. Fig. 92—Assembled and unassembled block carriers. Fig. 93—Operating lever, rack, hammer-assembly and firing-mechanism housing

of steel are used in the breech mechanism. Even from the same grade of steel it not infrequently becomes necessary to select varying grades of hardness as shown by the Brinell hardness tests to meet the different requirements.

Recutting Files

BY CHARLES E. KAIL

After reading over the article by S. A. Inscoe, on "Recutting Files," page 70 of the *American Machinist*, I am constrained to take exception to the last paragraph wherein he intimates that the acid method of recutting is inefficient and not much more efficacious than the wire brush, etc.

I am in agreement with him when he says in effect that no real mechanic can be deceived with an acid recut file, but that does not alter the fact that a considerable saving can be effected by the proper use of this method.

The process here described is to my knowledge in successful use by two companies, one doing the work on a commercial basis, the other treating only files used in its own plant.

This process is galvanic, being quite similar to electroplating except that the work becomes the anode and the cathode is supplied by the tank lining; the current flowing from instead of to the work.

A lead-lined tank is used, the bottom of which is covered with some insulating material to prevent too much cathode surface being exposed.

The negative terminal of the plating dynamo is connected to the lead lining and a brass bar extending across the tank and insulated therefrom is connected to the positive terminal. The solution used is sulphuric acid and water in a proportion of 1 to 5 and with a current of from 4 to 6 volts the work should be completed in about one-half hour.

The files are suspended vertically from the anode bar with suitable hooks and wires, and so arranged that they will be immersed in the acid up to the tang.

Files should be perfectly free from grease before going to the tank and to this end should be boiled in a strong solution of potash and then subjected to a thorough washing in hot water to make certain that there is no alkali carried over into the acid to remove the alkali.

To prevent the files from rusting after they have been sharpened, rinse them well in running water and then suspend them in boiling water containing a small amount of sal soda until they are heated through. They will then dry out without a sign of rust.

Enlisting Labor in Production

By L. W. SCHMIDT

Making labor interested in the part it is taking in production is one of the later methods used in Europe, and it has been found to increase the output. But equally important it has also been found that it developed a different mental attitude in the worker by widening his knowledge, stimulating his ideas and inculcating in him the meaning of responsibility. One way of obtaining the confidence and coöperation of the men is through the blackboard, the use of which is graphically explained in this treatise.

ON A recent visit to Europe to investigate industrial conditions I saw on a blackboard in one of the factories a chart about 6 x 9 ft. It showed two graphic curves delineating the monthly production of the factory and that of the industrial region comprising the Rhineland, Luxemburg, northeastern France and Belgium. The purpose of this chart was to show the workmen in the plant the relative importance of the factory as a producer of machines compared with other factories in the district, as well as to let labor understand the position of the firm as a leader in its particular field and to encourage it to take a pride in the prosperity of the concern. Similar boards were discovered in other parts.

A leading bank engaged in the financing of the Russian wheat crop, with the help of a graphic chart, kept before its employees the fact that a considerable percentage of the wheat crop of Russia had been financed each year by that bank and its correspondents. A more ambitious chart was displayed in the workshop of a machine-tool factory, which showed the yearly growth of the factory's business and its foreign connections, and there is no doubt that these charts have been of most value in educating the workman to take an intelligent interest not only in the workings of the factory which employs him but in the country as a whole.

Make Men Realize Importance of Their Work

What has been done in Europe might be done with still better results by the manufacturers of this country if factory managers, staff organizers and others were to make a more extensive use of educational methods to interest employees in their work and to implant in them a better understanding of the economic factors determining their own prosperity. Just now the nation is going through a period of great internal and external strain. The machine industry especially is called upon to accomplish feats considered impossible only a few years ago. On the successful completion of this task depends the future of the nation, and the utmost exertion, therefore, is demanded of all.

It is essential that everybody should understand what is demanded of him and that all engaged in the work of production should be enlisted not only as unthinking beings doing their work because they must earn a living, but as live factors intelligently accomplishing the work on which they are set. To gain this coöperation of all the productive factors of the nation more is wanted than the payment of high wages. Enthusiasm will have to be created. There must be the pride of individual accomplishments to the good of all.

To this end factory owners will have to take labor into their confidence. The man behind the machine must know what are the aims for which he toils with all the others around him; he must be made to see the importance of the achievement that is attempted.

The machinery industry today is an important link in the defensive position of the country. It provides the essential tools for all other industries. Successful and speedy operation of the machine industry, therefore, is absolutely essential to the general prosperity of the country. Every man should realize this fact. He should

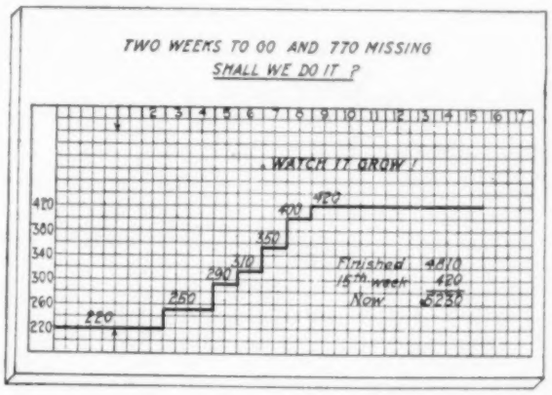


FIG. 1. SHOWING RATE OF PROGRESS

understand that every machine that cannot be supplied on the day it was promised may hold up the defensive preparations of the nation for weeks—may decide victory or defeat.

What is proposed here is not a complex system of education, necessitating lectures and attendance of the men after working hours, time better spent in recreation. It can proceed while the general work of the factory is going on. It is in fact closely related to the everyday duties of all the men engaged in the plant. Nothing is required but a number of large blackboards, white ink and an instrument capable of drawing white lines and writing figures and inscriptions. These blackboards should be placed where they can be seen easily by the working staff, one in the general office, one in the workmen's entrance of the factory and in other suitable places, and one in the workshops. The boards can be used for writing, or blueprints or other multiplied announcements may be displayed on them, which latter method saves a good deal of work. In every case the lines and type must be bold, so that they will be seen easily and will impress themselves on the mind of the reader.

Just now when the machine-tool factories of America have their hands full to keep abreast with production, many plants have had to double their output in order to satisfy the demands of the Government and private customers. Most orders are for earliest possible de-

livery and necessitate the employment of additional men and equipment. To finish the jobs as they come in and to make ready for new ones require the most loyal support of everyone in the factory. To gain this they should know the reason why, and they should be permitted to see for themselves.

Let us assume the case of a factory having accepted an order for 6000 tools to be delivered inside four months, the usual output being 900 tools a month. To execute this order it is necessary to increase the number of men and equipment. Here the blackboards will come handy. They will carry the initial announcement:

> TO OUR MEN
>
> The Government relies on us for the supply of 6000 machines, which we have pledged ourselves to deliver inside four months. To keep our pledge we will have to add new men to our forces. We shall also have to make an extension of the present factory equipment.
>
> Uncle Sam relies on us. We must rely on you.

After a few days this notice will be replaced by a new one. This will be a descriptive chart with the following inscription:

> Seventeen weeks to make 6000 tools. Shall we get there?
>
> Watch yourselves doing it.

The chart shown on the previous page is already in a state of progress; 15 weeks of the period of work have elapsed, and the final attainment is near. During the first week it shows the usual production of the factory during one week, which in this case is assumed to be 225 tools. As the work progresses and the new men and equipment begin to bear on production the number of tools produced every week increases, not always on an even basis, but rapidly. In the lower right-hand space the progress of the work is shown in figures in Fig. 1. These figures are changed every week, as should also the inscription on the chart.

When the job is completed the last week's production is filled out. The inscription on the chart runs now:

> 6070 tools produced in four months by our factory. You did it.
>
> Uncle Sam thanks you.

This kind of campaign has done good service, and its value as a "getting together" call lies in its appeal to the natural sporting instinct of the men.

The production figure obtained by the factory in the four months of the campaign may constitute a record of production. It is well to inform the men of this. It is peculiar that everybody likes records. One of the most uncomfortable nights I ever had was when I was crossing the Atlantic some years ago on one of the ocean greyhounds when it was endeavoring to establish a record, but all discomfort was forgotten next morning when I heard the record was beaten. People will work with greater zeal when they see something ahead of them, the achievement of which they may be proud of in later years. If a record for the factory, therefore, has been established this fact should be made something of. The men must be shown how it was obtained, and they should get their share of the success.

Another important purpose to which the blackboard can be put is educating the workman to his relation to the factory. This is a time when labor gets its full due. It has taken the leading place in constructive economics, but it has not yet taken on its shoulders the responsibility incidental to its new and increasing importance as an economic factor.

Wages have risen rapidly during the past few years in the machine industries of the country. Still labor clamors for more increases, resulting very often in disputes, though generally manufacturers have anticipated these disputes by making increases. There is today

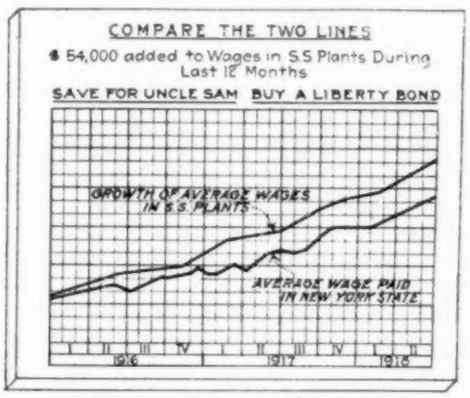

COMPARE THE TWO LINES
$ 54,000 added to Wages in S.S Plants During Last 12 Months
SAVE FOR UNCLE SAM BUY A LIBERTY BOND
GROWTH OF AVERAGE WAGES IN S.S. PLANTS
AVERAGE WAGE PAID IN NEW YORK STATE
I II III IV I II III IV I II
1916
1917
1918

FIG. 2. SHOWING GROWTH AND COMPARISON OF WAGES

no machine factory in this country which does not pay higher wages than a year ago. Labor has not yet realized fully the benefit of these increases. The rising cost of living in many cases has neutralized the effect of the additional wages. The increase, nevertheless, might be explained to the individual employee by demonstrating it to him in some form, but as the matter is one of great delicacy the presentation of the facts requires tact.

The belief that the men should be left in the dark as to the part they play in the factory is still subscribed to by many. My experience, however, seems to prove the contrary. The wage question has been tackled repeatedly and successfully by taking the staff into the confidence of the management, showing what has been done and instructing the men about the relative position of their own work in the earning scheme of the plant.

The facts demonstrated on a chart and plainly exhibited in the workrooms will help. The appeal will be stronger if it can be connected with some national question foremost in the mind of all at that time. The chart, Fig. 2, was used by a factory during the recent Liberty Loan drive.

It was displayed in the pay office of all the plants of the company. As will be seen it shows two curves. The lower designates the average wage disbursement of the national industry during 1916, 1917 and part of

1918, the upper the average wage paid in the factory making the display. The latter was considerably higher than the average wage, which is frequently the case in factories where specialties are manufactured and which consequently require a higher percentage of highly skilled labor. The instructive value of such a demonstration can be strengthened if the wage factor is also shown in its influence on the cost of production.

Wages, after all, are the governing factor of all price increases. Coal, while still in the ground, costs nothing, neither does the iron nor any other undeveloped raw material. All of these are gifts of nature and are useless in their natural state. All raw materials have to be won from the soil and improved before they

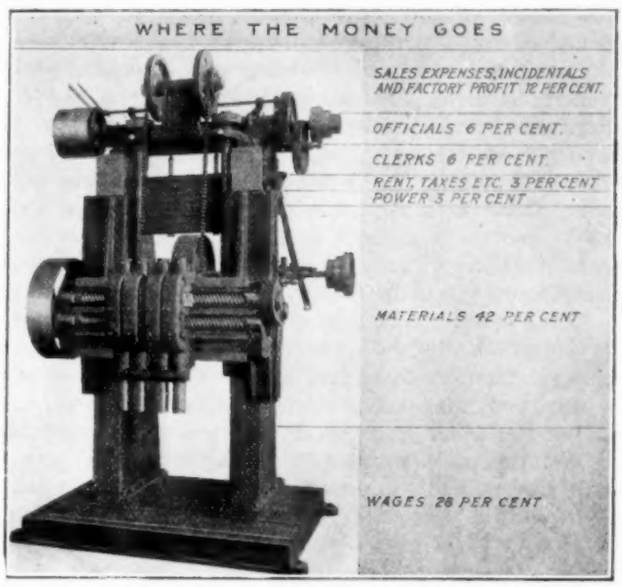

WHERE THE MONEY GOES
SALES EXPENSES, INCIDENTALS AND FACTORY PROFIT 12 PER CENT.
OFFICIALS 6 PER CENT.
CLERKS 6 PER CENT.
RENT, TAXES ETC. 3 PER CENT.
POWER 3 PER CENT.
MATERIALS 42 PER CENT
WAGES 28 PER CENT

FIG. 3. ILLUSTRATING MANUFACTURING COSTS

can be used for industrial consumption. In the case of iron the ore has to be mined; it has to be smelted and turned into the form in which it is bought by the machinery-building industry. Coal has to be mined, broken and transported to the power houses and places where it is required. Before the material has completed the process of improvement to the industrial form, before it has reached the point of consumption, it requires the application of labor. This labor has to be paid for and it is the principal factor in the cost of the material. By operation of this law the cost of iron increases with every step up to when it reaches the consumer.

How can this best be explained to the men?

In the *American Machinist*, Vol. 48, page 210, there is a chart describing the relative distribution of the cost of manufacturing a $100 unit of machine tools, which might be used with advantage to show to the men how profits are distributed. A better plan would be to demonstrate the facts on one of the machines built in the factory. The advantage of this method is that it reaches the less imaginative mind more easily than a chart, and its value to the factory lies principally in the unimpeachable correctness of the facts stated. Whenever a chart of this kind is laid before the men it must be worked out to stand thorough examination. Such a chart is shown in Fig. 3.

The drawing itself can be displayed in the usual manner. Several inscriptions will suggest themselves to the mind of the staff manager.

Another feature that can be handled by the educational method is the carrying out of general factory policies affecting the men and staff, the correcting of habitual faults, negligence and so on. Just now, when conservation has become an urgent necessity, waste should be eliminated wherever possible. The men are too easily inclined to believe that there is not much lost by their occasional negligence, and it is difficult to explain that continual waste must result in large losses of money and material.

Fines, warnings, notices and premiums have all been made use of with varying results. Neither of these methods, however, has been completely successful. Notices are forgotten as soon as the men have become familiar with them; fines are paid rather than care being taken, and soon things are back to where they were. Waste may occur in the careless use of supplies, in overapplication of power, in negligence in the handling of tools and machinery. As long as it was only a matter of money loss the harm was not so serious At the worst it meant only a reduction in profits, but today waste means the weakening of the defensive position of the nation, and concerns not only the factory but the country at large. This refers as much to power and coal as to cleaning rags, oil or whatever kinds of supplies.

To lay the situation before the men, even if only an incomplete result can be obtained, the outcome of the investigation should be made known to the employees and an announcement like the following is recommended:

> During the last month we have spent $ ..... for general supplies. Our power house has consumed ..... tons of coal. Uncle Sam needs oil, rags, screws, lead, copper and other supplies. Your home needs coal during the coming winter.
>
> We have been asked to conserve supplies and coal.
>
> Help us do it.

A few days after this announcement has obtained the necessary attention it can be replaced by a graphic chart showing the expenditure for supplies for the last three months and the consumption of coal. The inscription now reads:

> Do not waste supplies. Do not waste power.

As in the first instance the chart is continued from month to month with varying inscriptions.

If an improvement is noticeable, this fact should be made something of. Not only should full credit be given to the men, but the methods by which the improvement was obtained should be shown. Special suggestions should be invited and men having made accepted suggestions should receive a premium. A premium to be distributed to the whole force if considerable savings are made will have good results.

Experience has shown that this kind of campaign is nearly always successful. The men soon take an interest in the problems which are put up for solution and they will wait from month to month for the progress of the conservation scheme.

The first and principal rule of all staff campaigning must always be variety. If the charts and the blackboard have done their duty they should be dispensed with and another scheme adopted, as it is only by making occasional changes that it is possible to keep up the interest of the men, which of course must be the main object of the campaign.

Returned Soldiers and Sailors as Better Mechanics

By C. E. Shaffner

When the first quota of drafted men was leaving for the cantonment camps I heard a shop foreman say to a young machine operator who was answering the call: "Well, son, I guess it will be a long time before the old shop will look the same to you again." He was expressing the view frequently heard in these days of reconstruction that military and naval service unfits a man for return to his place in industry.

Perhaps this has been true to a great extent following wars in the past, but there seems little evidence at present that former soldiers and sailors will have any difficulty in adapting themselves to factory and shop work. On the contrary it appears that they are taking up their old tasks with an interest and energy that are nothing short of remarkable, considering the sudden change in their mode of living. I have reached these conclusions from observations made in different plants, and while of course I have not had an opportunity to deal with numerous cases I believe nevertheless that the instances which have come to my attention are typical.

Just as a kind of general illustration I have in mind the case of a young Canadian soldier who was invalided home some months ago and finally discharged from further service. When he left a Detroit factory at the outbreak of the war he had not carried with him a reputation as a very good mechanic, but when he applied to his former employers they gave him employment largely because of the scarcity of mechanics. They were agreeably surprised to find from the start such a remarkable improvement in his work that he was soon made a subforeman in a department which required particular accuracy in workmanship and close attention to details. Since the work he had to do consisted in the final assembly of a 3-in. antiaircraft cannon it is altogether likely that he displayed a keener interest in the proper construction of the finished product because of his service at the front, but the fact remains that his ability to take care of a great many small details of construction and his absolute insistence upon having them carried out properly had come undoubtedly from the military training he had received.

That this regard for small things, which may mean a great deal, especially characterizes the changed attitude of former soldiers and sailors is evidenced by the following instances which I have observed: A young man mustered out of naval service returned to his shaping machine in a Middle Western factory. A week later he suggested to the committee appointed for the purpose of receiving suggestions regarding improvements in factory methods and conditions that the electric lights over practically all the machines in his department be raised and in addition that close-grained wire netting be placed in front of a number of machines so that there would be absolute protection from flying chips of steel. Here were two matters of considerable importance which had been entirely overlooked, probably because they seemed too trivial. And yet they earned for the ex-sailor a money prize.

Another mechanic who had graduated from the tank service established a system of inspection in an Eastern factory, thereby eliminating delays which had previously seriously interfered with machining. He was placed in this department because his physical condition would not permit him to do heavier work. And what he succeeded in doing merely amounted to properly developing the working capacity of the inspection force. As a result a machine operator instead of having to wait for half an hour or perhaps longer because micrometers had not been passed upon was able to go ahead with his job simply for the reason that the inspectors had been taught to work faster and without needless delays in running around the factory to different tool cribs and in useless conversations.

As the months pass a great many more instances like those described by the writer will no doubt be disclosed as thousands of soldiers and sailors return to civil life. It will be decidedly interesting to note from a careful analysis of these cases what experiences and methods of training have resulted in a finished man product with new mental equipment for peace as well as war.

Accurately Spaced Drilled Holes

By Edward A. Stein

The article on page 88 of the *American Machinist* by Wilbur L. Coble entitled "Accurately Spaced Drilled Holes" is interesting, but the method here described has some advantages.

Instead of locating the button in the usual way, that is drilling and tapping for a holding screw, take a piece of flat cold-rolled steel of a thickness equal to half the length of the button, a width of twice the button's diameter and of sufficient length to allow for clamping to the work. Drill and ream a hole near one end in which the button will be a press fit, press in the button, taking care that it does not project on the bottom of the plate, then clamp the piece to the work.

After properly locating the button by tapping the piece with a hammer or a soft piece of metal give the clamp a final tightening and then drill the work, using the button as a drill bushing. The hole in the work can be enlarged, preferably with a counterbore that will allow for reaming with a standard hand reamer.

The foregoing method seems to have the following advantages: There is no drilled and tapped hole (for holding the button) to lead the drill off; and there is less chance of a smaller drill moving the bottom out of location than when using a drill equal to the diameter of the button.

This method is recommended on any job where a tolerance of + or — 0.001 in. is allowed. When closer limits are required the holes must be bored.

Testing Materials for Hardness

BY HOWARD ENSAW

During recent years many firms and individuals that were regularly engaged on work which did not necessitate any intimate knowledge of the composition or the structure of the material they were using have suddenly been called upon to acquire that knowledge. The material they use must satisfy certain specified tests

THE scleroscope and Brinell machine and even in some cases the sclerometer test have become very popular. These instruments are undoubtedly of considerable assistance if used with care, and the results applied in a correct manner.

In the case of the scleroscope a steel hammer is allowed a 10-in. drop in a glass tube which must be absolutely vertical. This hammer is about ¼ in. in diameter by ¾ in. long, and is tipped with a diamond striker. On soft material the tip penetrates further into the surface than on hard material, and in the case of case-hardened mild steel or hardened tool steel the impression is so slight and consequently the area covered by the diamond so minute that the force of the blow approaches 500,000 lb. per square inch.

The height of a rebound measured at the top of the hammer is taken as a measure of the hardness of the material tested. This is to a certain extent very convenient, but the operator should guard against applying his results without further consideration.

As the area covered by the diamond is so very small it is most difficult to detect the soft places without spending a great deal of time and letting the hammer fall a number of times in a small area.

When the hardener removes the object from the furnace for quenching, his tongs only touch the object on two or three small areas, but in some cases local cooling takes place before the object reaches the quenching bath and those places from which the heat was taken come out soft. A random scleroscope test on the article would possibly register a satisfactory degree of hardness, but the soft place would probably reveal itself when the article was in use. If an insufficiently high temperature is reached when reheating for the quenching then also we are likely to have soft places.

Other causes of soft areas are carelessness in grinding, the use of an unsuitable wheel or a correct wheel in bad condition and poor distribution of the cooling water. In any case the chances are that these soft areas may be missed when tested by the scleroscope, and an alternative test will be suggested later.

Also in this instrument we must admit that the rebound is really caused to a great extent by the material under test returning to its original state after being distorted by the blow of the hammer, and the rebound consequently must be a measure of the faculty of recovering its original state. This seems to show that the instrument is not applied properly because we do not desire to measure that faculty, and when materials which are not hard, when compared with a piece of annealed vanadium steel, can show a scleroscope reading as high as the latter then it is time to confine this instrument to its proper sphere.

In this connection it will be interesting for users of the instrument to take a piece of rubber and test this. The rubber should be flat on the top and bottom and placed on one of the standard test pieces supplied with the instrument. The test piece should then be placed on the anvil supplied and this will give a good, solid foundation.

The writer has recently tested three samples of celluloid under the scleroscope with the following results: The first sample gave 65 deg. of hardness, the second gave 60 deg., and the third gave 61 deg. These results would seem to indicate that the celluloid is harder than a sample of good quality cold-worked high-speed steel, but at the same time each specimen tried could easily be cut with a pocket knife.

A sample of bone registered 45 deg. of hardness, apparently being as hard as chrome-nickel steel, and could be cut with a knife. A sample of rubber gave 34 deg. of hardness, which corresponds approximately with annealed 1 per cent. carbon tool steel.

These results indicate that scleroscope values must not be used in too wide a field, and when making comparative tests it is advisable to confine ourselves to one brand of material only.

It may be said that if the limitations of this instrument are appreciated it can be put to a very useful purpose, particularly for obtaining a comparative determination of the condition of samples of similar material.

Testing by means of the sclerometer has not attained much favor in Great Britain, but as its action is not so local as the scleroscope it has an advantage in this way, but on the other hand it is not nearly so convenient to use. By means of a diamond under a fixed load a scratch is made on the test piece and the dimensions of this scratch are measured by microscope. These dimensions are then taken as a comparative hardness reading.

THE FILE TEST

In testing hardened-steel parts the file test is still remarkably popular, and although there are some objections to its use it probably gives the hardener more confidence in his conclusions than the more elaborate and scientific tests.

Quite a large percentage of hardeners in our factories today are men who were on the job before either Brinell or Shore began to make our metallurgists look at the hardness problem in a very serious light. The methods of the hardener at that time were remarkably crude, and as they were ignorant of the possibilities of recording the extent of hardness the necessity of the file test then is obvious. Hardeners are a careful and thorough set of men, but they look upon the works' chemist as a deadly enemy if he suggests new ideas or modern instruments. The result is that the file still has adherents and really is reliable.

It is a matter of regret that we cannot establish in connection with this test a figure for comparison. An article can be tested and we can guarantee it to be

hardened all over to a satisfactory extent, but we cannot place data on record for future reference, nor can we certify to a fastidious client that the article conforms to a certain degree of hardness.

As the quenched-steel articles are as hard as the file, the hard places destroy the teeth, and consequently the file cannot be used again in the same place. This means a great deal of expense in files when hardening quantities. Also the files themselves are liable to a considerable amount of variation, and a hardened ball race may damage a poor file without being sufficiently hard to perform the duty for which it is made.

Another hand-applied test is the bar test, which is carried out generally with a hardened-steel rod about $\frac{3}{16}$ in. in diameter. This rod is ground at the end, and by attempting to scratch the article under test a comparison of the hardness is obtained. When the corners are rubbed up the bar is again ground on the end. It will be noticed that by this method many cutting edges can be obtained, all of which are practically identical, and thus the results are more uniform than the file method.

In the case of the Brinell test (which was only put forward in its present state as late as 1910) we have a really good machine and the results are fairly reliable, but a great objection is that this test cannot be conveniently applied to articles merely hardened and quenched. The results are of extreme value in connection with materials as rolled or in the case of oil-hardened steels. In operation the test is simple, although it takes more time than the scleroscope, and when the test has once been made the impression always remains and can be easily read if the records are lost.

The Probability of Damaging Machine

A hardened-steel ball 10 mm. in diameter is pressed into the test piece with a vertically applied load of 3000 kg. The spherical area of the impression left after an application of 30 sec. is calculated from the diameter, which is measured by microscope. Then the pressure per unit area is taken as the Brinell-hardness numeral.

Obviously when the hardness of the material to be tested approaches the hardness of the ball in the Brinell machine then the probability of damaging the latter increases and this upsets the reading. As a regular practice it is best to test materials only up to about 578 Brinell number, which is represented by a ball impression of 2.55 millimeters.

We see then that in hardness testing there are several methods which can be used, each method having peculiar advantages for or disadvantages against operation within certain ranges, and it is not a difficult matter to choose the most suitable test for any specific case.

The limitations of each method should be fully realized and the danger of assuming too much from results should be guarded against. This fault is exhibited very much today in the case of ultimate stress of materials. It is often assumed that this value has a certain constant relation to the Brinell-hardness numeral. It is also frequently assumed that the scleroscope hardness number has a fixed and constant relation to the Brinell number, and unless matters like these are treated most carefully, trouble is likely to ensue.—[The author has failed to call attention to and emphasize the fact that all of the methods of testing hardness are comparative. A rubber ball will bounce higher than a lead ball if both are dropped from an equal altitude and strike a cubic foot of granite. If dropped from the same height into soft mud their rebound will be equal, but that does not mean that lead and rubber are equally resilient. With all of these methods of testing hardness certain standards are set up and similar pieces should test similarly to their standard.—Editor.]

Notes on the Care of the Steam Hammer

By A. S. Hesse

Hollow dies on a steam hammer are a prolific cause of breakage of the piston rods. The trouble occurs when the hammersmith has learned that the hollow exists and to obtain better work he works on one end of the dies instead of using the center. This practice puts a side strain on the rod which eventually causes it to snap.

The hammer dies should always be kept as level as possible and should come together flat. The front and back edges of the upper and lower dies should match and the corners should be rounded up equally on both sides. When the two dies line up well it is possible to forge a shoulder without first fullering or dressing it up by hand on the anvil.

The item of steam consumption is of importance in any shop, and the forge-shop foreman can aid in saving by periodically inspecting and making sure that the valves and piston rings of the steam hammers are in good shape. A steam hammer with worn and poorly fitting rings and valves is a heavy consumer of steam.

Exhausting the steam from the hammer into a shop-heating line is bad practice unless there is ample provision to guard against a variable back pressure. The valve gear of a hammer is composed of a slide and cam motion and held together only by the weight of the moving parts. A hammer has no fixed length of stroke, and an operator only learns by experience and practice to handle it properly; consequently when back pressure of varying degrees is added to interfere with the freedom of the valve motion he soon has trouble in properly regulating the blow.

When no provision is made on the live-steam line to remove the condensed water before it reaches the hammer other complications follow. The hammer must always be ready for immediate use when the smith reaches it, and water not removed from the steam line quickly chokes the cylinder and valve.

A common source of waste about the older types of steam hammers is due to their not being provided with automatically operated oilers. I have seen such hammers provided with a hand-operated oiler, which the helper worked now and then when he chanced to think about it. Each time he pumped from ½ pt. to 1 pt. of oil into the cylinder, and of course immediately the hammer went into use nearly all of this oil was blown out with the exhaust steam. An automatic oiler feeding a drop or two a minute only when the hammer is in use would be far more efficient, saving most of the oil otherwise used and insuring that the hammer would be efficiently oiled.

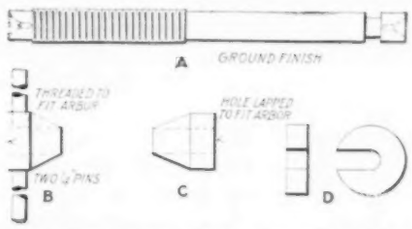
The best lubricant I have found for the guides of the hammer is a mixture consisting of 1 lb. of white lead thoroughly mixed into ½ gal. of heavy cylinder oil. This is applied with a brush to the guides, valve cam and slide and will stay on longer than machine oil.

Mandrel for Grinding Wristpins

By Edward N. Moor, Jr.

The drawing shows a quick-change mandrel for holding automobile wristpins for grinding.

Part *A* is made of machine steel casehardened and ground and of suitable diameter to slip onto the bore of the wristpin. The hardened cone *B* screws into the mandrel and carries two pins for the purpose of setting up the nut and also to act as drivers, thus doing away with the necessity for the dog. Part *C*, the other cone, is a push fit on the body of *A*, and part *D* is notched to fit the neck in *A*. For loading the mandrel part *B* is



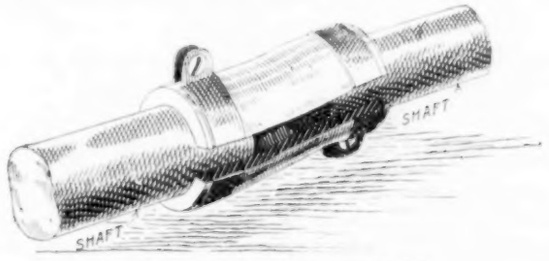
MANDREL FOR GRINDING WRISTPINS

left in place and is adjusted lengthwise to fit different lengths of pins. First slip on a wristpin and then slide on part *C* and drop part *D* into the notch. Hold the wristpin and mandrel in one hand and set up *B* with the other hand, using the two pins as a wrench.

An Efficient Flexible-Shaft Coupling

By W. Heusser

Two shafts each $1\frac{3}{16}$ in. in diameter were out of alignment about $\frac{3}{16}$ in. Commercial couplings were tried, but did not work satisfactorily. Finally the two



HOSE FOR SHAFT COUPLING

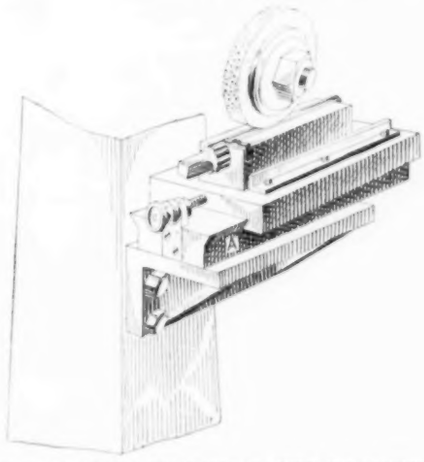
shaft ends were connected together by means of a short piece of heavy steam hose, as shown in the sketch. This coupling has proved satisfactory in every respect. It is noiseless and flexible, requires no oil and no attention whatsoever, besides being very cheap. The length of the hose is 6 in., the inside diameter $1\frac{1}{4}$ in. and the outside diameter 2 in. The wall is inlaid with heavy cotton fabric. It transmits 1 hp. at a speed of 350 r.p.m., has been running for one year and shows no sign of wear.

Grinding Taper Reamers in a Small Shop

By J. A. Lucas

In a little country machine shop, the grinding equipment of which consisted of a lone tool-grinding machine of the usual pedestal type with double end arbor, some taper reamers had to be reground.

The shop was what is sometimes known as a "one-man" or a "two-man" shop, having but one lathe, one drilling and one shaping machine, a power hacksaw, etc., including the tool-grinding machine referred to. There



DEVICE FOR GRINDING TAPER REAMERS

were four of the reamers, each of a different taper, and they had been purchased at odd times to meet special requirements.

A cutter and reamer grinding machine was beyond the proprietor's means, and even had it not been its purchase was not warranted by the amount of work that could be provided for it. There was no near-by shop with such a machine to relieve the situation, and the "old man" was thrown upon his own resources.

The tool-grinding machine had been fitted with a table by bolting an angle plate to the pedestal, and vertical

adjustment of the work could be accomplished by means of a separate device shown at *A* in the cut and which consisted of a pair of sliding wedges dovetailed together after the manner of the cross-slide of a lathe, and provided with an adjusting screw.

To grind the reamers a square block of cast iron was first planed up all over and a hole drilled lengthwise through it, this hole afterward being reamed with the taper reamer to be ground. One side was then planed away approximately parallel with one side of the tapered hole, intersecting the latter at a point that would leave one tooth of the reamer exposed for its full length.

With the reamer in the hole, care being taken that the exposed tooth was exactly in the center of the opening, the block was placed in the vise of the shaping machine, resting upon the edge of the exposed tooth, and the bottom of the block was planed parallel.

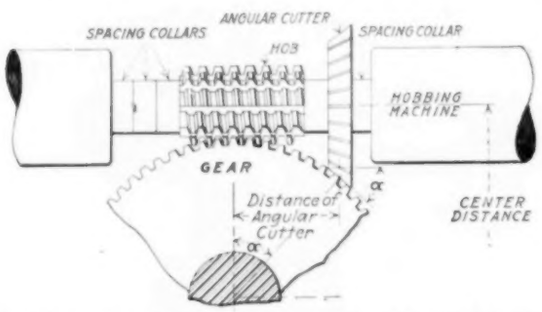
A steel finger for indexing completed the device and by running the block back and forth under the grinding wheel the reamer was ground as well as could have been done on a regular machine.

As the four reamers were of different taper it was of course necessary to provide each one with a block.

Sizing and Hobbing a Gear in One Operation

By Nikola Trbojevich

By mounting an angular cutter on the same arbor with the hob on the hobbing machine, as shown by the drawing, it is possible to cut a gear from a rough blank in one cut. The angular cutter takes care of the outside diameter, while the hob generates the teeth. This method of producing gears compares favorably with either of the other two usual methods: Turning the blank on a lathe or turret machine to the exact outside



SIZING AND HOBBING A GEAR IN ONE OPERATION

diameter and hobbing the teeth, or turning the blank to an approximate diameter and hobbing it with a so-called topping hob, a hob which removes metal from tops of teeth as well as from the sides and bottom. The first method requires a distinct, though, as a rule, not expensive, additional operation of turning. It also should be taken into account that when the forming of the outside and pitch diameters is done at two different settings and on two different machines the circles are likely to be not quite concentric, which is an error commonly found on gearing.

The topping hob obviates this latter difficulty with respect to the concentricity, but the amount of stock that can be removed with a topping hob from the outside diameter is somewhat limited. Besides there are some other difficulties connected with the use of topping hobs. In order to get a good-running gear it is often necessary to cut the teeth a trifle deeper than standard, while in some other cases a better result may be obtained by holding the hob back. In either case it is desirable to leave the outside diameter unchanged, which cannot be done with a topping hob.

It is interesting to note that the device, as shown in the cut, is adjustable within wide limits. By shifting the angular cutter toward or from the center line the outside diameter of the blank can be regulated, due to the taper effect of the arrangement. When the hob becomes dull and it is desired to shift it along on the arbor in order to bring another unused portion in contact with the gear it is only necessary to transpose one or more of the spacing collars from one side of the hob to the other. This will leave the angular cutter undisturbed in its position with respect to the center line because the total length of the hob and the spacing collars remains unchanged while the hob is shifted into another position.

The most advantageous angle and diameter of the angular cutter can best be determined from a fairly accurate layout by scaling. The nearest standard angle and diameter can be taken then because, as already explained, there is nothing particularly exact about the diameter and angle of cutter because of the adjustability of the mechanism. It is a good thing to place the cutter on that side of the hob which is advancing with respect to the gear blank, as then the cutter will work ahead of the hob and in that way size the blank before the hob had any chance to cut in.

It is also obvious from the diagram that the same arrangement may be used for cutting spiral gears.

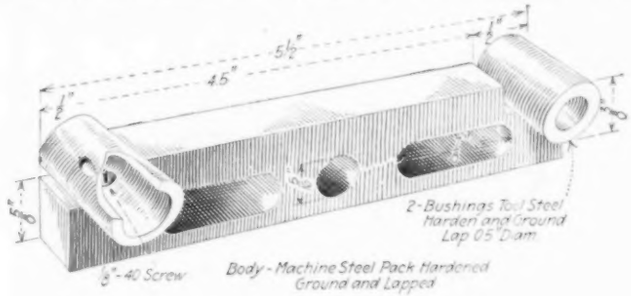
The above arrangement should be found useful in quantity production. A considerable advantage would be derived from the method in case of hardened gears having ground holes. As the outside and pitch circles are absolutely concentric the hole could be located rather from the outside than from the pitch circle, which would greatly simplify the problem of correctly holding the work in the grinding machine.—[We are in some doubt as to the practicability of this method, and for two reasons. Because of the angular position of the cutter arbor the cutter would not advance squarely to its cut but would have a tendency to turn the gear about its axis. This might or might not be detrimental to the surface produced, depending chiefly upon the rigidity of the setup. The principal difficulty, however, arises from the fact that the sizing cutter would reach the work an appreciable distance in advance of the hob, and the time wasted in feeding the cutter over this otherwise idle distance would serve to turn several gears in the ordinary manner.—Editor.]

A Simple Design of Sine Bar

By John Teckeer

One tool that is missing in the average toolmaker's kit is the sine bar. Micrometers, verniers, height gages and other expensive tools are there, but the sine bar is missing. This is due both to the scarcity of these tools and the difficulty of making one in working hours. The sketch shows a simplified design, accurate and much easier to make than the usual type.

As will be noted the diameter of the bushings must be accurate; the spacing, 4.5000 in., is equally important and the shoulders must be square with the sides. The



SIMPLE FORM OF SINE BAR

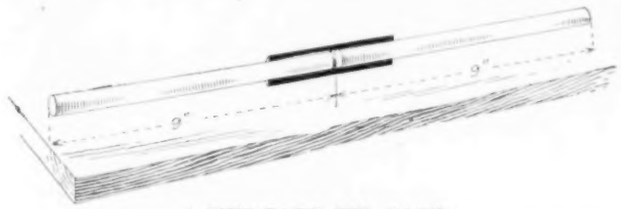
½-in. dimension can vary any amount provided both ends are the same. The slots and hole in the center are for convenience in attaching the bar to an angle plate.

Making Pin Gages Too Long for the "Mike"

By William Seelert

A clever shop kink came to my notice lately, which perhaps would be of interest to some of the practical men who read the *American Machinist*.

We had occasion to make some large pin and snap gages that called for a tolerance of 0.001 in. plus or



A TWO-PART PIN GAGE

minus, but were several inches larger than the largest micrometers in the shop.

This difficulty was overcome by making two pin gages, which afterward were held together by a snug-fitting bushing in the manner shown in the sketch. Thus an 18-in. gage was made by fitting two 9-in. pins. The latter came within the range of the outside micrometer available, and the necessary accuracy was obtained without trouble. The outside snap gages were adjusted to these pin gages. With this arrangement accurate gages can be made of two or three times the range of the largest "mike" on hand.

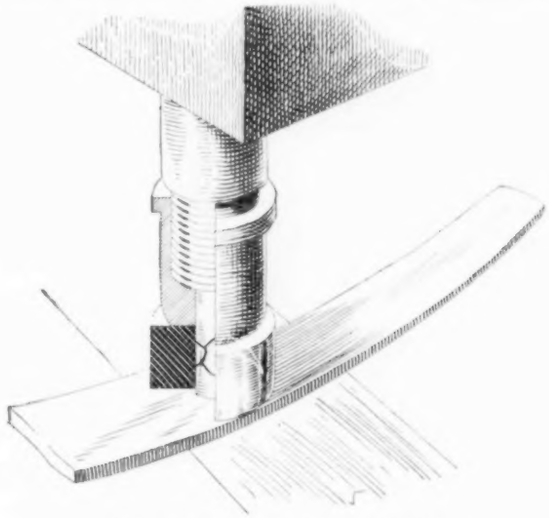
A Simple Guard for Punches

By L. W. Kinney

We have an operation of punching the center bolt hole in spring leaves. The leaves run from Nos. 6 to 00 B.W.G. in thickness, and when they are a little hard it is not unusual to break 20 or 30 punches in running a day's work of 30,000 holes. These punches in breaking often fly and injure the operators.

It is very difficult to arrange a guard that will protect the operator and at the same time not decrease the production. After trying several guards the idea was suggested to me of putting a soft rubber ring over the punch. The rubber compresses when the punch strikes the work, and when the punch breaks the particles are prevented from flying.

I have used these rings for over three years and have



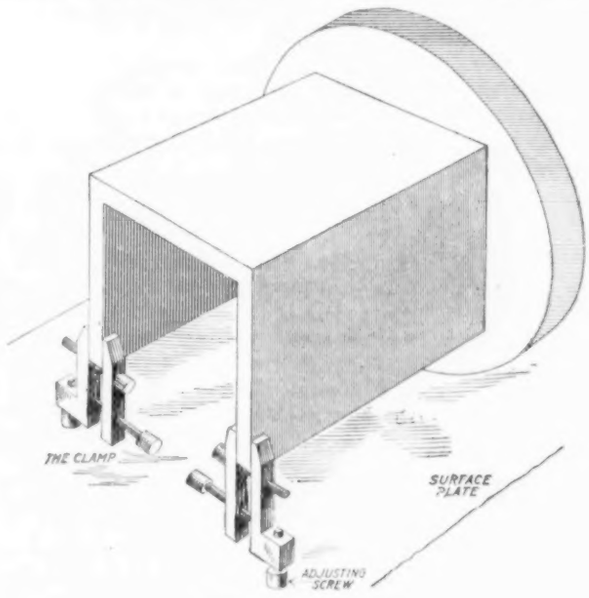
SIMPLE GUARD FOR PUNCHES

not had a man injured while using them. One rubber lasts about a week. The sketch shows the punch holder and punch with rubber ring in place.

A Handy Adjusting Clamp

By John Teckeer

A few days ago I noticed the inspector squaring up an awkward fixture preparatory to checking the dimensions. This particular casting was most irregular and



ADJUSTING CLAMP

had no favorable spots under which to set small jacks, nor was the finished surface convenient to strap against an angle plate. The outline of the fixture is shown in the sketch and the method of using the clamps is apparent. I believe the idea to be worthy of a wider field, so I am passing it along.

Lest We Forget

One of the greatest lessons we have learned from the war is that 80 per cent. of preparedness consists of "knowing how."

AS LONG as warfare is a possibility we must keep alive that knowledge of the engineering of war that we have gained at so much cost. This is not jingoism but common-sense patriotism.

At the outbreak of war the total commissioned personnel of the Ordnance Department was about 100 officers, whose collective knowledge of ordnance engineering, one of the most highly specialized sciences, represented the sum total of ordnance knowledge available to the War Department. Now several thousand civilian engineers have learned at least the rudiments or essential principles of this science.

Ordnance manufacture was known to less than a dozen arsenals, and considerably less than a hundred private plants in the United States. Now several thousand of our manufacturing plants, including practically all of our principal machine shops, have dealt with it.

Relations have been established between our regular army officers, our reserve officers, our manufacturers and our civilian engineers. It took time and cost many lives to establish these relations and to build up this working acquaintance.

What are we going to do with it?

Until the time comes when it is unmistakably safe to let this knowledge die, it is the sacred duty of every manufacturer, every civilian engineer, every regular officer and every reserve officer who has been connected in any way with ordnance to keep this knowledge alive and these relationships continued.

To facilitate this end and to promote the establishment of an American Ordnance Association which will include the officers who remain with the Government, the reserve officers who go back to private life and all of the civilian engineers and manufacturers who make ordnance possible, the *American Machinist* announces the establishment of a new editorial section known as "United States Army Ordnance News." In this section will be presented what has been learned by experience concerning ordnance design, manufacture, inspection and test. Personal notes concerning the members of this association will enable new acquaintances to be made, old acquaintances to be renewed or continued, and promote a community of fellowship between those who have evidenced their belief in preparedness by having served in our shops or army departments.

Additional pages will be added to our editorial section so that the incorporation of this material will not decrease the amount of our normal subject matter.

When the League of Nations throws the guns of the world upon the scrap pile, then, and not until then, can we safely forget what we have learned. Let each of us in the meantime serve our country by keeping alive the knowledge gained by experience and adding to it. It is a very practical thing that each of us can do toward the assurance of peace.

(See Page 263 of this issue)

U.S. ARMY ORDNANCE NEWS

HOW ORDNANCE IS INSPECTED

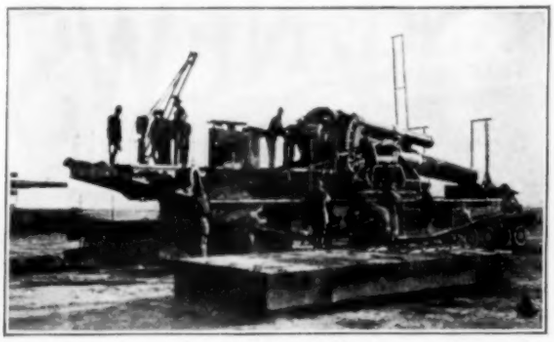
BY FRED H. COLVIN

THE Inspection Division of Ordnance has had its troubles, and they have been many. No organization can deal with more than 5000 contractors of all kinds, not to mention many more subcontractors, on a great variety of products and have smooth sailing all the way. As with other branches of inspection it has been the buffer between two opposing forces and has been "cussed" with equal fervor by both sides, but just as the shop inspector who plays the game squarely and has a fair amount of tact can eventually show both sides that he is a help and not a hindrance, so the Inspection Division came into its own.

There are of course as many varieties of inspectors as there are of contracts. And it is absolutely impossible to gather a large force of inspectors at short notice and under the trying conditions of war without picking some undesirables, the same as in any other business; but these were weeded out as fast as possible, and the average manufacturer today admits that the men of the Inspection Division helped production. The various proving grounds are the best evidence as to the quality of the munitions supplied. The Inspection Division has 12 branches in which we are particularly interested, these being artillery ammunition, carriages, education, explosives, gages, guns, instruments, machines and containers, metallurgical, proving ground, small arms, small-arms ammunition and trench warfare. The heads of these divisions are all shown in the organization chart which accompanies this article and which also shows the duties of each officer and the particular work which he directs.

The personnel of the Inspection Division during the first week in November consisted of 709 officers, 775 enlisted men and 26,450 civilians. Among them were one or two men who had been receiving from $50,000 to $60,000 a year before entering the service; 25 or more received over $10,000 a year, and with few exceptions every man entered the division at a financial sacrifice. Of the 709 officers there were 1 brigadier-general, 2 colonels, 15 lieutenant-colonels, 72 majors, 221 captains, 306 first lieutenants and 92 second lieutenants. Among the civilians all but 728

The Inspection Division has been called the watchdog of quality, but it is more than that. It has been the coördinator of the manufacturing capacity of the country. It has helped manufacturers to obtain greater tolerances where necessary; it has shown them how to get production in many cases; it brought together the makers of different components and helped keep the stream of munitions flowing to our boys in France. Its men, both military and civilian, faced the dangers of explosion in every loading plant and at the proving grounds, losing only twelve men in the great disaster at Morgan.



Preparing to load a monster howitzer. This is one of the late railway mounts. The cylinder above and to the right is one of the four recoil cylinders.

were employed in the district offices, this being divided as shown in the table. The large proportion of females is somewhat astonishing, and while the great majority of them were employed in a clerical capacity, there were a number doing government-inspection work in the various divisions, the heads of the various branches speaking highly of their work.

TABLE I. CIVILIAN PERSONNEL OF INSPECTION DIVISION ON NOVEMBER 2, 1918

	Males	Females	Total
Philadelphia	2,287	1,925	4,212
New York	1,975	1,591	3,566
Bridgeport	1,797	1,361	3,158
Chicago	1,143	917	2,060
Rochester	1,085	819	1,904
Toronto	874	904	1,778
Detroit	918	819	1,737
Cincinnati	845	812	1,657
Cleveland	927	571	1,498
Boston	466	953	1,419
Pittsburgh	649	733	1,382
Washington	337	616	953
St. Louis	243	155	398
Total	13,546	12,176	25,722

Personal equation counts in the Inspection Division to an even greater extent perhaps than in any other. Contractors occasionally went to Washington to complain of the inspector in their plant, but when asked to make specific charge or to state in what way they would have his decision changed they were unable to do so. Different temperaments clash instead of coöperate, and this was more noticeable with the Inspection Division and the contractors because of the constant contact between the two, but nearly all branch heads can cite instances where a transfer of inspectors proved beneficial to both sides.

The Question of Tolerances

The question of tolerance always arises wherever there is inspection, and this probably caused more disputes than anything else. Often have contractors gone to Washington to obtain greater tolerance on various parts, and having been successful found themselves no better off than before. Others were refused increased tolerances because most of the other shops doing the same work had no difficulty, and it was proved to them that the trouble was not so much with the tolerance as with their organizations.

An outcome of the insistent demand for specified tolerances was that it led to improved shop practice, as shops that formerly did not or could not work to fairly close limits were educated to find it possible and profitable to do so. Contractors have stated that whereas they thought they were doing good work before, it was war work that taught them what good work really is.

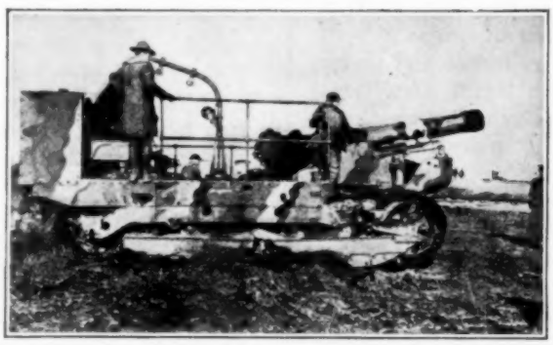
Other contractors admit that contrary to expectations the proportion of rejected material was frequently higher where large tolerance was permitted than where the work was held within close limits. This may only be explained by the psychological effect exercised on the worker who unconsciously becomes careless when a wide limit of error is allowed. In this connection, it may be well to call attention to the bad practice in some shops of using working gages of a wider limit of tolerance than the final-inspection gages. This often comes about from the habit of selecting gages as they come from the toolroom and keeping the most accurate ones for the final inspection and allowing the less accurate to be used on the work as it comes from the machines. The most successful contractors reverse this procedure and never allow the shop as much tolerance as can be passed in the final inspection. By this means they are assured that anything that satisfactorily passes the shop gages will be passed by the final inspection, and sometimes work that may have been rejected by the shop or working gage can be finally passed by the inspector's gage.

Gages Last Longer With Women

Again, in the matter of gages, an officer of the Inspection Division who was responsible for large production of shells and other ammunition unhesitatingly voiced his preference for women inspectors, first, as we might perhaps have good reason to expect, because their delicate touch was a distinct aid, and second, which is an entirely new idea to most of us, because the gages lasted longer when used by women than by men. This may be attributed to the same delicate touch and is not surprising, even if it has been overlooked in the past.

In ordinary manufacturing the Inspection Division has been the mediary between the contractor and the designer, in this case the Engineering Division, in endeavoring to obtain more liberal tolerances and also to influence design in view of its effect upon manufacturing. In this way it acted in a dual capacity, and when manufacturing got well under way it was admitted that the Inspection Division had done excellent work and had been instrumental in obtaining this production.

In the beginning all inspection work was centralized



Mobility is one of the greatest assets of artillery. This 9.2 howitzer can be fired directly from the tractor without the necessity of bracing of any kind.

in Washington, but this was not found as efficient as desired, so district offices were established. One of the big advantages accruing from this was the rapid adjustment of misunderstanding and the settlement of uncertainties without delay. The traveling supervisors who were first used found it impossible to visit the various districts often enough to prevent work being delayed. The visits of contractors to Washington were also unsatisfactory to both sides, as it often became necessary to refer to past correspondence and to review the whole case. After April, 1918, however, when the district offices began to function, there was a noticeable improvement in production, due in no small measure to their being able to take up and to settle nearly all questions without delay.

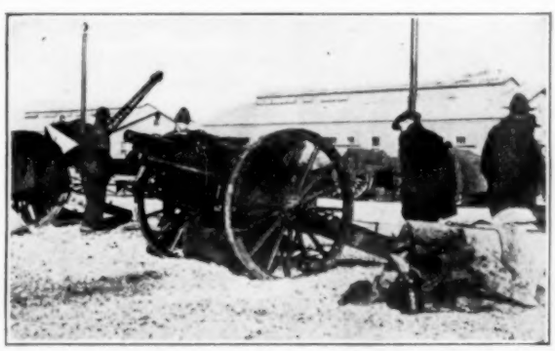
Engineering Division Decides Tolerance

Questions of tolerance or of design of course had to be decided by the Engineering Division, and this led to the placing of a representative of this division in each office. This course was not altogether satisfactory largely because of the difficulty of obtaining engineers who were familiar with the many products that were made in a single district. And, just as electrical-apparatus manufacturers and others have a central engineering department which coöperates with their district offices, it seems that a similar arrangement should be best for Ordnance.

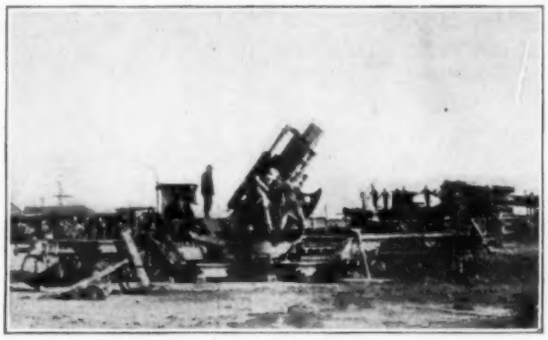
The field of activity of the Inspection Division is much broader than is understood. Planning, for example, which we always think of as being solely a function of production, plays an important part in the Inspection Division, and is divided into branches and groups, such as the Analysis Branch, the Records Branch and the Order of Work Branch. Each branch has one or more groups, as follows: In the Analysis Branch are the Schedules and Estimates Group. In the Records Branch, the Contract-File Group, the Progress Group, the Blueprint and Specifications Group, and the Index Group.

Work of the Schedules Group

The Schedules Group investigates contracts and ascertains whether or not the contract has been lived up to in detail, and takes steps to rectify any errors. It gets advance information from the Control Bureau or Procurement Division in regard to the material, quantity and kind, with the drawings and specifications applying



A gun that the French ordnance experts pronounced superior to their 75. The American split-trail 75 has greater latitude in elevation and traverse.



A mortar with a mount designed for use on the railways in France. Mortars are used in the destruction of earthworks and forts and fired at high elevations.

to each which enables the Inspection Division to have its inspectors on hand with the proper equipment as soon as the manufacturer has material to deliver. This is a marked improvement over the old system, where the Inspection Division was informed after the material on contract had been manufactured and was ready for inspection. The record of all contracts for ordnance, ammunition, equipment, material and stores is kept by this group, so that quick reference is always obtainable and shipping instructions available when material is ready. Approximately 100 contracts a day were handled by this group.

Reports Compiled by the Estimate Group

The Estimate Group audits all civilians' and officers' travel vouchers, averaging 30 a day. It compiles reports showing the cost of inspection per unit, audits vouchers covering purchase of material by ordnance departments. The Contract-File Group has a copy of all requisitions, procurement orders, contracts, amendments and other papers pertaining to ordnance orders. These files are also used by the various groups to distribute the material pertaining to war orders, such as progress reports, new data, etc.

Progress Reports on 8000 Contracts

The Progress Group distributes, files, checks and furnishes information about the weekly progress reports. Five copies of progress reports on 8000 active contracts went into this office each week, the majority being received during the first three days. They had to be carefully matched up, distributed and rapidly handled in order to correctly route such a large number of reports to the operators who desire them. This group also looked after delinquent reports and supplied information to the district offices.

The Blueprints and Specifications Group belongs to the Records Branch and supplies information to the sections and groups of the Inspection Division. It maintains a reference file containing copies of all ordnance drawings and specifications, and supplies all the sections of the Inspection Division with drawings for the inspection of material being manufactured. The index records of all ordnance material, numerical, alphabetical, geographical and the kind or nature of the material, are maintained in the Index Group. The numerical index is a complete serial file in which all numbers under

ordnance classification are filed either as active or completed contracts. This also shows whether the inspection is being carried on through the Ordnance Department or not, also supplying full information regarding an order upon which only the number is known. The alphabetical index is filed according to the name of the firm; the file is also supplemented by all available subcontract information, which is automatically supplied from the various districts. Until the installation of fixed records there was confusion over subcontractors, these being unknown to the Ordnance Department. The other files have their own fields of usefulness, as has the Interbureau Record which shows whether part of an order has already been inspected or purchased by another division, such as aircraft, construction, engineers, etc.

Vehicles for the transportation of supplies are important. This caterpillar-equipped cargo carrier will travel on soft ground and climb grades of 45 degrees.

The Order of Work Branch distributes and routes all kinds of contract information to the Inspection Division and district offices. This information includes copies of letters sent by the negotiator to the contractor, procurement information cards, requisitions for contracts and procurement orders or contracts. This branch distributed about 400 orders daily, seven copies of each requisition and four copies of each contract being necessary to supply the parties interested. It also routes incoming and outgoing reports, mail and documents for the Planning Section. It forwards and follows up requests for information necessary to keep the various cards and files up to date. It is the connecting link with other divisions of the Ordnance Department on proper routeing methods in order to bring about the greatest efficiency in the distribution of information.

The Metallurgical Branch

The Metallurgical Branch of the Inspection Division has made a name for itself which few realize. Beginning with Capt. A. A. White (not a relative of the present head, Maj. A. H. White) and a stenographer in May, 1917, the branch has developed until there were 425 engineers of tests in the field in addition to the office force necessary to maintain the records in Washington and at the district offices. This clerical force was remarkably small, considering the amount of work it handled. The difficulty of getting men with the right training led to the establishment of training schools at Carnegie Technical Institute at Pittsburgh giving a six-weeks' course to those who already had at least two years of college work along similar lines. This was not confined to men, as there were about 20 women in the force, which number would have been increased had the war continued. While some of the work consisted of chemical analyses, such as where one project for 20,600,000 shells for 75-mm. guns required over 80,000 chemical tests, the bulk of it was physical, the physical tests running up to more than 700,000. Watching the heat treatments is the hardest task in this branch, and it is very important that there should be an observer at each furnace at all times to note the heat used and to check up the results.

Some idea of the size of this job may be had from the fact that a record is kept of the heat of every contract of every size of shell, and these records are instantly available in the Washington office. This meant the checking and recording of from 3000 to 3500 records every 24 hours and this was done with a force of not over 20 people in the office, a record which can hardly be equaled in business offices boasting of great efficiency. To show that these are not all simple records a few are reproduced herewith.

Each District Has Inspection Metallurgist

Since the adoption of the district plan each district has an inspection metallurgist who supervises all metallurgical work in his district and is responsible for the acceptance and rejection of all material from a metallurgical standpoint. This includes raw-material plants producing ferrous and nonferrous metals, specifically, steel mills; steel and forging plants under the same management; cannon-forging plants; plants producing armor plates for tanks, tractors and carriages; smelters and refineries; bronze, brass and other nonferrous alloys; rolling, milling, spinning, stamping, cupping and drawing plants, etc. In addition to the inspection of material in various stages of construction, this division must be kept in touch with the whole field and it is constantly called upon to give advice on and to decide matters which, if decision is not rendered, delay the production of material which is urgently needed. As a sidelight on this part of the work the record of 12 days' work last March shows some interesting data. In addition to routine letters, which count up in any office, this branch wrote 408 letters deciding some

A 75 mounted integral with its means of locomotion. The speed with which this gun can be brought into position, fired and again be under way is astonishing.

matters at issue (known as "judgment" letters) and took part in 890 conferences on matters pertaining to the work of the branch. The record of the Metallurgical Division in reference to steel shells, for example, begins with the furnace and gives the heat number, code number, date poured, date fractured, size and weight of ingot, number of blooms accepted and rejected, number of bars accepted and rejected, amount of the top and bottom discard, additional discard for chemical and physical reasons, kind of fracture, kind of surface and mill loss. These records have enabled the different mills to know exactly what they were doing, and in some cases to improve the quality of their output. The shell inspection is complete and gives the heat treatment of every lot, number of pieces in the heat, dimension of the test piece, elastic limit and ultimate strength, elongation and reduction of area, fracture bending test, Brinell reading and maker's chemical analysis.

An 8-in. coast-defense rifle equipped with an improvised mount for field service. Very high velocities and long ranges are obtained with this defense rifle.

Personals from the Ordnance Department

Gen. Guy E. Tripp, formerly chief of the Production Division of Ordnance, who separated from the service on Nov. 21, 1918, and returned to his duties as chairman of the board of the Westinghouse Electric and Manufacturing Co., 165 Broadway, New York, is a director in the American Surety Co., S. R. Avis & Sons, Inc., Bryant Electric Co., Canadian Westinghouse Co., Ltd., Chase National Bank, Interborough Consolidated Corporation, Interborough Rapid Transit Co., Krantz Manufacturing Co., the Morris Plan Co. of New York, New England Westinghouse Co., R. D. Nuttall Co., Pennsylvania Electric Co., Penn Barrel Co., Pittsburgh Meter Co., 145th Street Crosstown Railroad Co., J. Stevens Arms Co., Wabash Railway Co., Westinghouse, Church, Kerr & Co., Inc., Westinghouse Electric and Manufacturing Co., Westinghouse Electric Export Co., Westinghouse Gear and Dynamometer Co., Westinghouse Lamp Co.; chairman of the board of Westinghouse Metallfaden Gluhlampenfabrik Gesellschaft m.b.H., Vienna, and chairman of the board of Westinghouse Metal Filament Lamp Co., Ltd., of London. He is a member of the following clubs: American Yacht, Bankers' Club of America, Crow Point Golf, Economic Club of Boston, Economic Club of New York, Engineers Club of Boston, Exchange Club of Boston, Greenport Car, Greenwich Country, Hingham Yacht, India House, Lotos, Metropolitan Club of New York, Railroad Club of New York, Union League Club of New York, University Club of London and Wompatuck, Hingham, Mass. He is also a member of the Business Federation of America, Chamber of Commerce of the State of New York, Chamber of Commerce of the United States of America, Council on Foreign Relations, Greenwich Casino Association, Inter-Racial Council, Japan Society, Jovian Order, National Geographic Society, National Marine League, National Security League, New York Board of Trade and Transportation and Philippine Society.

Officers in the Ordnance Department who have served in the American Expeditionary Forces are being returned to this country in considerable numbers. When the armistice was signed almost exactly one-third of the officers of the department were overseas and others were going at the rate of about 1 per cent. a week.

Nearly all of the officers returning are being discharged and as many of them serving in America as can be spared. Up to Jan. 28, 1591 had been discharged, or more than a fourth of the whole number.

Most of the officers who were recruited for work with mobile ordnance repair shops and who were not attached to tactical organizations or sent overseas have been discharged. These officers had intensive training in repair and maintenance of motor equipment and ordnance matériel. They are thoroughly familiar with machine-shop practice and operation. There were over 200 of these officers, and practically all will return to their former homes in the automobile centers of the Middle West.

Among the officers recently discharged is Capt. Robert C. Davis, who was for a long time a member of the Washington Examining Board. He had just returned from 11 months' service overseas on important work.

Equipped with two Ford engines this two-man baby tank will negotiate at speeds that are surprising. The skids at the rear prevent back somersaults.

First Lieut. Lloyd B. Duntley of Minneapolis, Minn., who was employed by the Emerson-Brantingham Co., before entering the service, was discharged on Jan. 29.

Maj. Joseph G. Woodbury, who was formerly with the Remington Arms Co., Bridgeport, Conn., was discharged recently. He is also a veteran of the Spanish War.

Capt. Samuel W. Burford,

who has just returned to civil life, was formerly with the Cleveland Mining Co., Cleveland, Ohio, as mining engineer.

Capt. Walter M. Ruby of Oneida, N. J., has been discharged. He was in the service nearly 20 months and was promoted to a captaincy in June, 1918. He studied at Massachusetts Institute of Technology and was for a time with the H. H. Franklin Manufacturing Co., Syracuse, N. Y.

Second Lieut. S. N. Kellogg, who was recently discharged, was formerly with the Packard company at Newark, N. J. He was promoted from the ranks and became an instructor at the Motor Instruction School at Raritan Arsenal.

Lieut. Robert C. Black of Lima, Ohio, had over a year's service at Rock Island Arsenal. In civil life he was a mechanical engineer engaged in locomotive construction with A. R. Ayers of Cleveland, Ohio.

Maj. William C. Rogers, who has been discharged, was for many years connected with the New York Department of Labor. He served as Deputy and Acting Commissioner of Labor and chairman of the State Industrial Board. His work in the departemnt has been on industrial problems.

Lieut.-Col. Bernard T. Converse, discharged Jan. 29 after 14 months' service, was promoted to that grade in August, 1918. Before entering the service he was with the Baldwin Locomotive Works at Philadelphia.

Lieut.-Col. Egbert Moxham was recently discharged. He entered the service as major in January, 1918. Before being commissioned he was president of F. B. Foster & Co., Philadelphia, and was previously vice president of the Ætna Explosives Company.

Lieut.-Col. E. Tyden, general factory manager of Rock Island Arsenal, returned to civil life after two years of active service in the Ordnance Reserve Corps. A retired business man of unusual ability and perception he was brought to the Rock Island Arsenal from Washington, D. C., through the urgent request of the late Colonel Hillman at the time of the latter's appointment as commanding officer. As general factory manager he has had much to do with speeding up production at Rock Island Arsenal during the war.

Col. Harry B. Jordan, Ordnance Department, U. S. A., succeeded the late Col. L. T. Hillman as commanding officer at Rock Island Arsenal. Colonel Jordan is a native of Kentucky, being born Feb. 26, 1876. When the expeditionary forces of the United States were sent to France Colonel Jordan was one of the first ordnance officers sent abroad, where he was placed in charge of the construction of arsenals. For more than one year he was at this work, and was then brought back to the United States with the rank of colonel and placed in charge of the artillery section in the office of the Chief of Ordnance.

Expansion of Rock Island Arsenal

For some time prior to the outbreak of the war in 1914 the employees at Rock Island Arsenal totaled approximately 1800 men and 175 women, the latter all office workers, typists and stenographers. From that time until the spring of 1916 there was little tendency to increase the number of workers, but at that time the disturbance on the Mexican border started increased activities here, and by July 1, 1916, there had been added to the force about 100 men and 25 women, the latter still being confined to clerical positions. From that time until the United States entered the war employees were added at the rate of about 200 a month, and on Apr. 6, 1917, there were employed 3600 men and 300 women office workers. High speed and maximum production then became the watchword and employees were added at a rate of about 250 to 300 a month. On Dec. 31, 1917, the total was 6100 men and 376 women office workers. On May 31, 1918, this total was increased to 8926 men and 450 women office workers. About 100 women shop workers had also been employed. The first of the women shop workers were employed May 20, 1918, and when the armistice was signed about 1500 women were employed in the shops. The following table shows the increase in the number of employees during the war period:

	Men	Women
August, 1914	1800	175
July, 1916	1900	200
April, 1917	3600	300
January, 1918	6100	376
May, 1918, (office 100) shop	8926	450
July, 1918	10,268	572
August, 1918	11,244	722
September, 1918	11,899	902
October, 1918	12,342	1227
November, 1918	13,361	1417

Applications of Electroplating

Electroplating played an important part in war work. Zinc plating furnished an excellent and, in many cases, the best protection against the corrosion of steel parts, such as airplane and seaplane fittings, fuse parts, hardware on ammunition boxes, etc. Black nickel plating was very extensively used for producing the so-called "government bronze" finish on brass hardware and saddlery equipment. Lead plating proved valuable in the lining of gas shells and for bringing up to standard weight shells which were underweight. In connection with these problems a number of investigations were conducted at the Bureau of Standards, whose experts made frequent visits to munition plants to advise upon the best methods of securing the desired results.

Appropriations have been requested by the Department of Commerce to permit more exhaustive study by the Bureau of Standards of plating problems and their application to various manufacturing industries. Electroplating is an industry which while not itself of great magnitude is often of fundamental importance to larger industries. Thus electroplating is essential to the manufacture of tools, builders' and saddlery hardware, plumbers' supplies, gas and electrical appliances, automobiles, silverware, jewelry, stoves, household utensils, mechanical devices, such as phonographs, cash registers, sewing machines, adding machines, typewriters, cameras and other optical and scientific instruments and in fact almost every industry in which finished metal articles of any description are produced. Progress in the art of electroplating will bring about corresponding improvements in all such industries.

Pending the appropriation of funds adequate to conduct extended or exhaustive investigations on electroplating, arrangements have been made by the Bureau of Standards to obtain by inquiries addressed to platers reliable information regarding the kinds and methods of plating now in commercial use. From such a preliminary survey it is hoped to get much information that can be made immediately available.

US ARMY ORDNANCE NEWS

The award of the Distinguished Service Medal to Maj.-Gen. C. C. Williams on Jan. 18 comes as a fitting recognition of the services of a soldier, engineer and executive who made good on both sides of the Atlantic during the war. For General Williams, as chief ordnance officer of the A. E. F. from May, 1917, to April, 1918, was the man who built and guided the tremendous machine that kept Pershing's boys supplied at all times with ordnance materials.

After the emergency machine abroad was built and running General Williams was sent to Washington to apply his experience and skill to the completion of the gigantic ordnance organization in America. Far less romantic was the work at home, and possibly it was harder work too, but the importance of it was emphasized by Secretary Baker when he made the following remarks accompanying the award of the highly prized medal:

"When we think of war we usually think of the battle front, and in this war we usually think of the trench, and its dangers are known to us all. The other side, however, does not come in for as ready appreciation and as full comprehension, and therefore I am particularly glad on this occasion to have an opportunity of saying a word about the other side. There is no rivalry of merit between the soldiers who were obliged to perform their services here and the soldiers who performed theirs abroad. They were all soldiers, and the first maxim of the soldier's calling is that he shall do his duty to the best of his ability where those charged with the responsibility of final direction designate his duty to lie. That errors are made in those designations goes without saying and it may very easily be that some men went abroad who might better have served at home, and that some served at home who could have served abroad with greater skill; but in the exercise of as impartial and uncolored judgment as was possible in the War Department the best interest of the nation was always the guiding principles, and as the result of our judgment a very large number of officers of the Regular Army of large experience were designated to do duties in this country. I perhaps more than anybody else am qualified to speak with authority of the splendid spirit with which those orders were accepted, the superb energy, skill and devotion with which those duties were performed."

The citation of General Williams reads as follows: "Maj.-Gen. C. C. Williams, U. S., Chief of Ordnance.

"For exceptionally meritorious and distinguished services. An officer of high professional attainments, who rendered particularly valuable services in the organization of the Ordnance Department of the American Expeditionary Forces and exhibited unusual ability in arranging for the procurement of ordnance material and ammunition for the American Army in France."

General Williams was born in White County, Georgia, his father being Capt. J. H. Williams of the Confederate Service. Captain Williams moved to Washington, D. C., when his son was 14 years of age. Here young Williams attended public school and graduated from high school in the class of 1889. He then entered West Point in 1890, graduating fourth in his class in 1894. From 1894 to 1896 he was at Fort Henry, Baltimore, Md., having been assigned to the Fourth Artillery stationed there.

General Williams, besides being a man's man, is a very modest gentleman, and it is very probable that the reserve officers who served under him and the manufacturers who coöperated with him know comparatively little about his personal history.

In 1896 he entered the Artillery School at Fort Monroe, leaving in April, 1898, to join the Sixth Field Artillery stationed at Washington Barracks. In May, 1898, he joined the Astor Battery, which was commanded by the present Chief of Staff, General March. He accompanied the Astor Battery to the Philippines, and in September, 1898, was made an aide on the staff of General MacArthur. In the latter part of 1898, he was transferred to the Ordnance Department and ordered back to the United States to take station at the Rock Island Arsenal. He remained at the Rock Island Arsenal until May, 1899, when he was ordered to the du Pont Powder Co., Wilmington, Del., for service lasting two years.

He then served a "tour" in the Ordnance Office, went again to Rock Island Arsenal for another "tour" of duty, and from there went to the Bethlehem Steel Co., where he was stationed from September, 1906, to September, 1908.

His next station was at the Watertown Arsenal where he remained until November, 1914.

Sent to England in 1912

While stationed at the Watertown Arsenal he was sent to England in January, 1912, for the purpose of studying the Hadfield methods of making shell. The Hadfield patent rights had been purchased by the Ordnance Department and General Williams was sent to the Sheffield Works of the Hadfield company to study these methods in anticipation of them at the Watertown Arsenal.

In November, 1914, General Williams was ordered to Germany as a military observer. The party of military observers remained in Germany from December, 1914, to April, 1915. During this time they visited the German lines at various points between Strassburg and Bapaume; also Antwerp, Louvain, Malines, Brussels and a number of other Belgian cities, and the eastern front in Poland at several places.

After his return from Germany General Williams was detailed for duty with the Ordnance Board at Sandy Hook, where he remained from May, 1915, to June, 1916, when he was detailed to the Southern Department as the chief ordnance officer. This was the time of the mobilization of the National Guard on the Mexican border and the future Chief of Ordnance gained considerable experience in the supply of ordnance material to troops at this time.

In March, 1917, he was ordered to the Ordnance Office in Washington and appointed a member of the machine-gun board which selected the Browning machine gun and the Browning machine rifle as the service weapons for the United States forces.

In May, 1917, General Williams was detailed as chief ordnance officer of the American Expeditionary Forces and accompanied General Pershing to France, where he was chief ordnance officer until ordered home in April, 1918. He was then designated Acting Chief of Ordnance and remained until appointed Chief of Ordnance July 16, 1918.

"Locating Knocks in Motors"

By Benjamin F. Miessner

My attention has been called to an article on page 107 of the *American Machinist* entitled "Locating Knock in Motors," by B. Z. Reiter, and I feel impelled to make some comment on the device therein described.

With all due regard to the genius and well-meaning of Mr. Reiter I think that it must be perfectly plain to anyone versed in either the science of acoustics or of electricity that the device in question cannot but fail completely to function for the purpose Mr. Reiter describes. Perhaps I will be pardoned for calling this fact to the attention of your readers before they become too interested in the device as described.

It would be instructive to know by just what channel Mr. Reiter proposes to transmit vibrations of the steel point to the telephone earpiece, assuming that the steel point is pressed against a vibrating portion of a gas engine.

Flexible telephone cords with a tinsel conductor certainly will not transmit the vibrations unless the cord be maintained in tension between the earpiece and the collar, which, it appears, is not intended nor would it be efficient. If this be the case, why is an electrical device—the telephone receiver—used?

If, on the other hand, the device is supposed to operate electrically it is difficult to understand why the telephone terminals are connected together and attached to the collar, inasmuch as the telephone is thereby short-circuited, so that even if by some magic method an electric current could be set up in the locating tube it could never reach the telephone windings and produce sound.

It is really a remarkably novel idea, and it would certainly be interesting to know whether Mr. Reiter has ever actually constructed and tried the scheme as illustrated.

Another Gage Joke

By James H. Follen

Dixie's gage joke on page 1172, Vol. 49, of the *American Machinist* goes to show how some men in responsible positions look on the problem of gaging work, but sometimes the joke is on the workman.

Way back in the dark ages when everyone was building bicycles Ole had a job turning hanger axles to a snap limit gage. The job being piecework Ole was running two lathes and making them "step lively," with the result that the pieces were not very accurate.

Ole being a firm believer in the well-known shop adage, "You can take off but you can't put on," rather leaned to the oversize idea, and on going over a pan of finished work representing quite a few dollars on his pay check found practically all of them larger than the go limit. He was somewhat worried, but hit on a happy solution. Picking out the largest axle he went over to the toolroom and succeeded in grinding out the go gage without anyone noticing him.

The work on going through the inspection room was of course rejected and the foreman on comparing Ole's gage with the master plug wanted to know "Howinell that gage got so large," whereupon Ole cheerfully admitted having ground it out and tried to square himself by saying, "Ay tank it bane a lot quicker to grind the gage dan to turn dam axles down all over again."

The "Coverage" of the Compensation Acts—I

By CHESLA C. SHERLOCK

The "coverage" of the workmen's compensation acts is a matter of paramount importance to all employers of labor, no matter what their immediate business may be. Under the term "coverage" many points of mutual interest arise and to determine what is the "coverage" of the acts is to determine who are employers, who are employees and what injuries are to be compensated.

COMPENSATION acts generally have had to be optional, or partly so, on account of the constitutional or judicial limitation placed on the right of the state to deprive employers of their old common-law defenses.

Under the optional acts, an employer may, within a certain specified time, either accept or reject the terms of the acts, but in either case he is deprived of the old common-law defenses of contributory negligence, assumption of risk and the fellow-servant rule. If he comes under the terms of the compensation acts his liability is certain and fixed, being determined by the schedule annexed to the acts; if he elects to remain under the common law his liability will depend on the ability of the injured workman to recover in an action for damages.

Not every person employing labor or using the services of another is deemed in law an employer, so it is important to determine just who are employers in order to fix the "coverage" in given cases.

The various acts themselves attempt to define the status of employers, but most of these definitions mean nothing until judicial interpretation has been obtained. Many times the courts have so distorted the evident meaning of the legislature or have so modified the definition that it has assumed a different meaning.

When Is an Employer an Employer?

For instance, if a man is conducting a shop employing less than five workman, is he an employer in the meaning of the compensation acts? In some states he is; in others he is not. Or, if a machine shop takes an order which places the proprietor in the position of an independent contractor for that particular work, does he become an employer under the act? This question of the independent contractor will arise again when we come to consider who are employees, so the distinction must be kept in mind.

The business in which the employer is engaged has a great deal to do with determining his status under the compensation act. A man may own a machine shop and employ 50 laborers to work for him. If he has not rejected the terms of the compensation act he is deemed an employer under the act and bound by its provisions, but if he is engaged in farming he will not ordinarily be deemed an employer under the compensation act and cannot be bound by its provisions.

Evidently the legislatures did not wish to impose liabilities of compensation on farmers, both from an economical and political standpoint, but this reluctance served only to impose the greater hardship by excluding him from the benefits of compensation, for an injured farm hand may obtain judgment in court by other means.

This example shows that not all who employ labor are employers within the technical meaning of the law. It has been said on good authority that if the act fails to specifically mention a certain class of employers they are deemed to be within the "coverage," and must be insured against liability. Employers specifically excluded by the terms of the act are excused from heeding its provision, and it is on them the choice of coming within the act or staying out falls, unless they happen to be doing business in one of the states having the so-called compulsory law.

Farmers Not "Employers"

In Illinois a machinist was employed by a farmer to take a threshing machine to a shop and have it repaired. On the way, he fell off the machine and was run over and killed. The Industrial Board held that the farmer was not liable because, being a farmer, he was not an "employer" under the Illinois act. The same board held that one injured while operating a threshing machine was not entitled to compensation for the same reason.

In Ohio the term employer includes every person, firm, private corporation and public-service corporation that employs five or more workmen.

It is advisable to keep in mind one important feature of the compensation acts, which is that the injured workman can come under the operation of the compensation acts only when his employer has become bound; otherwise his only remedy is to bring civil action for damages. Bringing the employer under the terms of the acts automatically throws the mantle of protection over all of his employees, unless an employee desires to reject the acts, which right he ordinarily has after the employer has exercised his right.

In Ohio the owner of a shop that occasionally employed five workmen was held to be an employer. The Ohio act does not specifically mention the word "partnership," but it was held that a partnership employing five or more workmen is an employer. This decision is quite universal. The mere fact that the employer is a partnership will not excuse it from the terms of the compensation act.

The Washington Act

The Washington act includes contractors, subcontractors, owners, agents and municipalities, but it does not include the United States. The state has the right to impose the compensation legislation on all public corporations and make it compulsory, but it has no right to impose the system on the United States Government. The federal government, however, adopted a compensation act of its own in 1917.

The status of one as an employer does not finally depend on the definition set out in the acts so much as on the relation between employer and employee being in existence. Subject to those excluded any person who

stands in the relation of employer to other persons who stand in the relation of employees will be deemed an employer for the purposes of the acts. In this connection it has been held that if the owner of a business dies and an administrator is appointed such administrator is deemed an employer and must pay compensation to a workman who is injured while engaged in the duties of his employment.

If a creditor takes over a business to operate it in order to discharge its debts, he is deemed an employer and is liable for the payment of compensation.

The same is true of a receiver who has assumed control of a business.

The Status of Third Parties

An employer cannot escape the payment of compensation on the ground that the workman was hired and paid through a third party, such as an agent. The agent stands merely in a representative capacity and his employer is the one deemed to be the employer under the compensation acts.

An employer cannot dispose of his liability by contracting it away. If the owner of a machine shop should make a contract, specifying that the party for whom he was doing the work should pay all compensation claims arising in performing the work, he cannot say to his men: "Your employer is the man for whom I am doing this work. He has agreed to pay your compensation. Go see him." The employer must pay the compensation, no matter where the liability falls.

It often happens where there is cordiality between employers that one will temporarily "lend" some of his workmen to another. If the workmen so "lent" are injured while in the other's employ, who is the employer when it comes to collecting the compensation? The courts have said that an employer cannot escape liability under the acts by such temporary "loans" of his employees. However, if an employer says to one of his workmen: "Go over to Jones' shop next week and help him out; he will pay you a bonus of $10, and when he gets through with you, come back to your old job here," if he should be injured in the meantime compensation will not be chargeable to Jones.

Where two or more employers are involved in cases such as the foregoing, some interesting situations arise. The test usually applied is not who has the authority to discharge the workman or who exercises supervision over his work, although these are important, but whether the act is done in the business where the person in control is the proprietor and has the right to stop or continue the work or determine the way it is to be done.

The situation may be reversed. A workman may have more than one employer at the same time. Will this prevent him from receiving compensation? For instance, business men owning property in proximity frequently hire one watchman to make the rounds of all of their establishments, and each employer contributes a part to his wages. In case of injury, who must pay the compensation? A case is recalled where a watchman so employed was killed on the premises trying to beat off robbers. It was held that the employer upon whose premises the man was killed should pay the compensation and that the rate of payment should be determined by the wages received from all his employers.

It is generally held that where the accident occurs when the workman is doing work for several employers he cannot be denied compensation because of this dual employment and that he has the right to elect the employer he will proceed against.

A deputy sheriff who was hired by a private employer to watch his premises while so engaged was stabbed by a prowler. It was held that although he could not recover compensation as a deputy sheriff he was entitled to relief from his employer. This case was decided in New York.

Ordinarily the owner is deemed the employer, but it was held in Wisconsin that it was not the intention of the compensation act to render the owner of the premises liable in compensation to the employees of his tenant, and no doubt this construction of the act would obtain elsewhere.

The California Act

The California act provides that the principal as well as the employing contractor shall be liable for the payment of any compensation the contractor might be liable for, and it has been expressly held that where a contractor is liable the principal is also liable, although the work done was not in the course of the usual business of said principal. The English act makes a similar provision, but makes the test of liability depend upon whether or not the principal would have been liable had the injured workman been in the principal's employ at the time of the injury. This distinction is worth knowing because many of our compensation acts are copied bodily from the English act.

If the employer is an independent contractor he is deemed the employer for the purposes of the compensation act and is liable for the payment of compensation to his injured employee. Where he is not an independent contractor, but merely stands in a representative capacity or acts as agent for another, he is not liable as an employer.

Where the case involves principal and agent practically the same rules apply. If the agent unknown to the employee hires a workman and the workman is injured the agent is not deemed the employer, and where the principal knows of it and does nothing he is held as ratifying the acts of his agent and is liable.

Question of Whom Work Was Benefitting

In questions entailing agents and principals the test is to determine whom the work was benefiting and whom it was for. If for the agent then the agent is the employer; if for the principal then the agent is not the employer, although he is the one hiring the workman and exercising supervision over him.

Where individuals or quasicorporations may in fact be the employer they are not given recognition in law as having sufficient entity to occupy that status in the technical sense, but the Illinois board has held the trustees of the University of Illinois liable for an injury occurring in the college buildings.

Another matter under this point, which is more important than all the others, is that employers often assume that as soon as they obtain a policy of compensation insurance and pay the premium on it they have discharged their full liability to their employees and can no longer be held for payment; but the fact

one or more forms. In some states he pays his premium into a state fund; in others he insures his liability in a private corporation or association, but if the corporation or association becomes insolvent or the state fund exhausted the workman may proceed against the employer. The liability of the employer is never extinguished as long as the injured workman is unpaid.

Meeting of Crane Manufacturers and Government Representatives

A meeting was held Jan. 22 at Cleveland, Ohio, between locomotive-crane manufacturers and representatives of the Government charged with the disposal of surplus machinery and materials.

Lieut. Col. A. LaMar represented the Director of Sales. There were also present Maj. W. W. Houston, representing the Director General of Military Railways; Sheldon Carey and William H. Waite of the Browning Co., Cleveland, Ohio; Alexander Brown and Melvin Pattison of the Brown Hoisting Machine Co., Cleveland, Ohio; Benjamin Dixon, Industrial Works, Bay City, Mich.; H. G. Steinbrenner, Orton & Steinbrenner, Chicago, Ill.; C. F. Michael, Ohio Locomotive Crane Co., Bucyrus, Ohio; F. W. Lovell, McMyler Interstate Co., New Bedford, Ohio; and R. P. Shimmer, Link Belt Co., Chicago, Ill.

A statement of the policy of the office of the Director of Sales was made by Colonel LaMar, and the agreement which was made with the Machine Tool Manufacturers' and Dealers' Association was referred to. The suggestion was made that the surplus-equipment menace, which affected the machine-tool industry, also affected the crane-manufacturing industry, and it was proposed by the crane manufacturers that the same agreement made with the machine-tool manufacturers would be advisable in this case.

Wants Government to Take Surplus

The crane manufacturers believe that an effort should be made to induce the Railway Administration, the Navy and other Government departments to take over as many of the Government-owned surplus cranes as can be used before any effort is made to induce the manufacturers to take the cranes back.

After considerable discussion the crane manufacturers decided not to approve or disapprove at this time the Government proposition as adopted by the machine-tool manufacturers and builders. It was agreed that individual manufacturers should make a statement of the value of his cranes to other governmental departments and to the railways. This is necessary because a considerable portion of the surplus cranes is not such as would be readily marketed in the United States under present conditions. The statement, among other things, will show the estimated cost of modifications which would be required.

A meeting of the crane manufacturers will be held in Cleveland on Jan. 30, at which time this statement will be coördinated and forwarded to Washington for information and action.

It was suggested at this meeting that the crane manufacturers are anxious to coöperate with Government representatives in disposing of this property, and they will be glad to furnish any information which they can obtain, or they will help in the disposal of the property to other departments if desired

Twenty-four 9-ton cranes, type 29, 8-wheel, 40-ft. boom (equipped with French draft rigging and 16 M. C. B.); manufactured by the Osgood Co.; price paid, $12,400.

Forty-seven 15-ton cranes, type B, 8-wheel, 48-ft. boom, M. C. B. standard appliances; price paid, $18,250; 14 of the above to be equipped with magnet and generator and single-sheave block; price paid, $19,900; manufactured by Brown Hoisting Machinery Company.

Ten 15-ton cranes, 8-wheel, 45-ft. boom, M. C. B. standard appliances; manufactured by Bucyrus Co.; price paid, $20,680.

Two 15-ton cranes, 8-wheel, 50-ft. boom, French draft rigging; manufactured by Link Belt Co.; price paid, $18,566.

One 15-ton crane, 8-wheel, 48-ft. boom, French draft rigging; manufactured by Brown Hoist Co.; price paid, $17,075.

Three 15-ton cranes, 8-wheel, 45-ft. boom, M. C. B. standard appliances; manufactured by Ohio Locomotive Crane Co.; price paid, $19,800.

Five 15-ton cranes, 8-wheel, 40-ft. boom, French draft rigging; manufactured by Orton & Stein; price paid, $15,566.

Ten 15-ton cranes, type E, 40-ft. boom, M. C. B. standard appliances, 7½-kw. generator sets; manufactured by Industrial Works; price paid, $21,453.

Thirty-four 15-ton cranes, type E, 40-ft. boom (12 to have M. C. B. standard appliances and 22 to have French draft rigging); manufactured by Industrial Works; price paid, $19,870.

Two 20-ton cranes, type G, 8-wheel, 40-ft. boom, French draft rigging; manufactured by Industrial Works; price paid, $22,402.

Four 20-ton cranes, type G, 8-wheel, 50-ft. boom, French draft rigging; manufactured by Industrial Works; price paid, $21,730.

Three 15-ton cranes, No. 8, 8-wheel, 50-ft. boom, French draft rigging; manufactured by Browning; price paid, $19,415.

One 20-ton crane, No. 8, 8-wheel, 46-ft. boom, French draft rigging, magnet and generator; price paid, $22,135.

One 20-ton crane, No. 8, 8-wheel, 50-ft. boom, French draft rigging; price paid, $18,985.

Five 20-ton cranes, 8-wheel, 50-ft. boom, M. C. B. standard appliances; manufactured by Joliet Bridge and Iron Co.; price paid, $21,000.

Two 20-ton cranes, 8-wheel, 50-ft. boom, French draft rigging; manufactured by Browning; prices paid, $19,080 and $19,420.

Seven 25-ton cranes, type H, 8-wheel, 50-ft. boom, French draft rigging; manufactured by Industrial Works; price paid, $24,718.

Eight 25-ton cranes, type H, 8-wheel, 45-ft. boom, pile-driver attachment (four equipped with French draft rigging and four with M. C. B. standard appliances); manufactured by Industrial Works; price paid, $28,012.

Three 30-ton cranes, model F, 8-wheel, 50-ft. boom, M. C. B. standard appliances, sister hooks; manufactured by Ohio Locomotive Crane Co.; price paid, $25,700.

Two 35-ton cranes, type L, 8-wheel, 40-ft. boom, French draft rigging, wrecking tools with spare parts; manufactured by Industrial Works; price paid, $27,240.

Nine 35-ton cranes, type L, 8-wheel, 45-ft. boom, magnets and generators, outriggers (two equipped with French draft rigging and seven with M. C. B. standard appliances); manufactured by Industrial Works; price paid, $34,132.

Three 15-ton cranes, type C, M. C. B. standard, 15-ton capacity, 8-wheel, 45-ft. boom; manufactured by Ohio Locomotive Crane Co.; price paid, $19,800.

Eighteen 50-ton wrecking cranes, type P, M. C. B. coupler and trucks, pump and fire hose, lighting equipment (17 are without booms and can be equipped with long booms for erecting purposes, 3 are equipped with curved booms); manufactured by Industrial Works; price paid, $32,865.

Nine 15-ton cranes, 2.4-m. (7-ft. 10½-in.) gage, hinge of boom 17 ft. above track, 48-ft. 3½-in. boom, self-propelling, double drum; manufactured by Variety Iron Co.; price paid, $20,300.

Fifteen 10-ton cranes, 2.4-m. (7-ft. 10½-in.) gage, hinge of boom 17 ft. above track, 48-ft. boom, self-propelling, double drums; manufactured by Brown Hoisting Machinery Co.; price paid, $16,884.

Six 5-ton cranes, 2-boom, electric cargo unloaders, 65-ft. booms, span of gantry 44 ft. center to center of rails, operated by 3-drum electric hoist; manufactured by Clyde Iron Works; price paid, $30,100.

Great Britain's Import Restrictions

After March 1, 1919, except by special license, no machine tools, metal-working machinery or wood-working machinery will be allowed to enter Great Britain

The list specifically includes the following: Machine tools and machinery driven by power and suitable for use in cutting, stamping or working metal, including lathes, grinding machines, milling machines, boring and turning mills, drilling machines, power presses, planing, punching and shearing machines, shaping and forging machines, screw machines, cutting-off machines, chucking machines, gear-cutting machines, boring machines, centering machines, and slotting machines; machinery driven by power and suitable for use in cutting, working or operating on wood, including sawing machines of all descriptions, general joining, mortising, tenoning and boring machines, lathes and rounding machines, box and cask making machines, and all machines accessory thereto; scraping and sandpapering machines, wheelwright machinery, firewood making and bundling machinery, wood, wood-fiber and pulp machinery, saw sharpeners and setting machines, saw stretchers and brazing apparatus, and machines for grinding, planing or molding iron.

The general English editorial comment ascribes the motive for this restriction to the widespread lack of employment and a desire to encourage hand labor as an antidote for this lack of employment. This would hardly be as logical a reason, however, as would the natural desire to protect English machine-tool builders as much as possible. The handwriting on the wall points unmistakably to protective-tariff restrictions in many lands and on many articles formerly exempt.

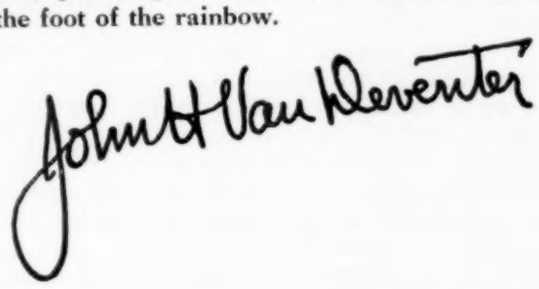
Whatever the reason for Great Britain's restriction on the importation of labor-saving machinery there are two comments that seem to be timely. The first is that labor-saving machinery is the embodiment of human intelligence in metal. Labor-saving machinery is the medium through which and only through which human brains and mechanical genius can increase or create wealth at a faster rate than it is consumed.

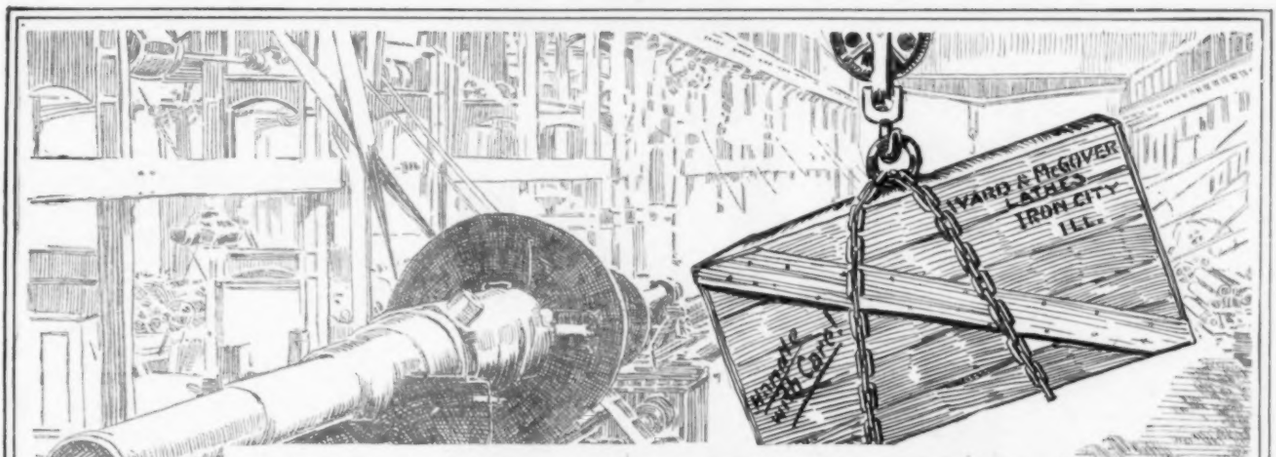
Thoughts, no matter how good they are, do not benefit mankind until they are put into motion. Labor-saving machinery puts the best of the world's industrial thought into motion. A general embargo on machinery is a general embargo on brains. No nation can afford to adopt the exclusion of brains as a national policy.

The encouragement of hand work as a cure for unemployment is not a wise move. We say this in a spirit of friendliness, because from the standpoint of selfish competition America will be the gainer and not the loser through the effects of this act. The hand cannot compete with the machine.

The second is that American machinery builders who are seeking export trade should not bank too heavily on the export field. They should go after it by all means with all the ability and the energy that they possess, but they should remember that this restriction by Great Britain is an indication of some of the obstacles that they will meet.

Give some of your thought and energy to the development of our own home markets. Between the Mississippi and the Rockies lies a vast territory filled with virgin industrial possibilities that as yet remain almost untouched. Encourage by all the means in your power the development of this territory as a national policy, for with it will come an enormous market for American-made goods. The pot of gold is sometimes nearer than the foot of the rainbow.





SHOP EQUIPMENT NEWS

Edited by
Stanley M. Banfield

Jones Superior Gear-Hobbing Machine

A new and powerful gear-hobbing machine has recently been brought out by the Jones Superior Machine Co., Chicago, Ill. It is designated as the company's No. 48 and was originally planned to handle gears up to 48 in. in diameter with face widths up to 20 in. However, the actual results have been such that it is used to cut gears as large as 72 in. in diameter. The minimum diameter of gear that may be handled in the machine is approximately 10 in., depending somewhat on the diameter and pitch of the hob. This relatively small diameter of work handled is obtained by undercutting the column, as indicated at *A*, Fig. 1, in such a manner that the table may be fed in until it swings beneath the ways for the hob saddle. The column has a total depth of 34 in., so that notwithstanding this undercutting it extends far enough to the rear of the machine to afford a sufficiently firm base to take care of the heaviest cut without vibration.

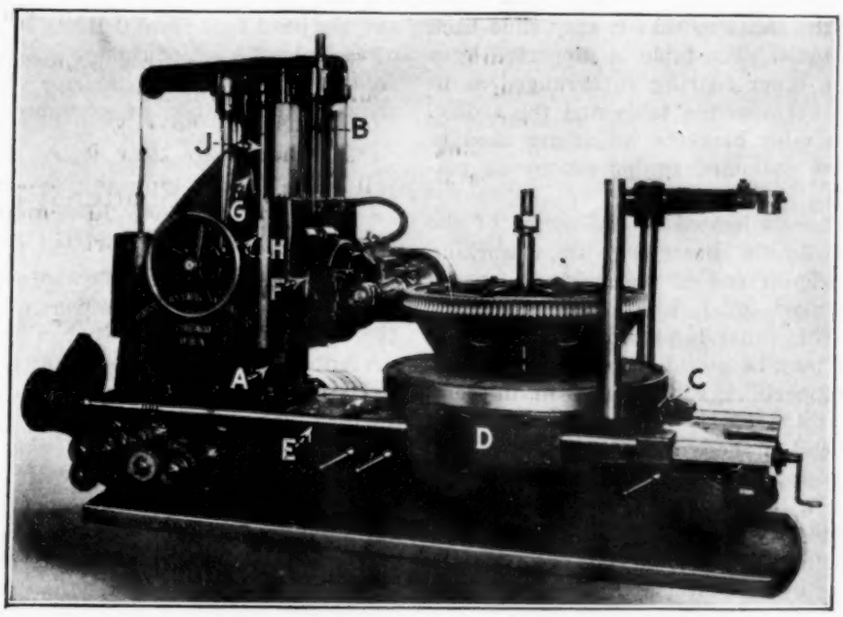


FIG. 1. OPERATING SIDE OF SUPERIOR NO. 48 GEAR-HOBBING MACHINE

Rated size of gear-hobbing machine, to cut gears 48 in. diameter by 20 in. face; actual capacity, 72 in. maximum and 10 in. minimum diameter; weight, 14,200 lb.; floor space, 121 in. long by 64 in. wide; base, 14 ft. 2 in. long by 36 in. wide; total height, 80 in.; table diameter, 45 in.; standard work arbor, 2¾ in. diameter and 18 in. long; standard hob arbors, 1¼ in. and 1½ in. diameter; countershaft speed, 350 r.p.m.; countershaft pulley, diameter 16 in., 4½ in. face; cone pulley diameters 16, 14¾, 13½ and 12¼ in. by 4½ in. face; spindle speeds using back gears, 38 to 115 r.p.m.

The base of the machine is heavy and it has been reinforced where possible to obtain rigidity. The unusual width of the square table ways will be noticed. These are 5 in. wide, with correspondingly wide sides. The well for the storage of the cutting oil is located in the interior of the base and is cast as an integral part. It is of the two-chamber type separated by a perforated screen to remove the chips before the oil flows into the chamber from which the pump draws. Provision has been made for the removal of chips and dirt accumulations from the settling chamber by a door in the side of the base. A centrifugal pump is supplied for handling the coolant, and its flow is regulated by a valve which may be closed completely without danger to the pump. Four ways have been provided to insure adequate bearing surface for the column saddle; the two outside ways are 4 in. square, while the two narrow inside ways *B* give additional firmness and support. The table has eight T-slots, and is surrounded by a wide groove for catching the coolant. The table is 45 in. in diameter and is driven by a worm gear located at the outside diameter of the table beneath its edge and just inside of the housing *C*. The design is planned to place the worm where the smallest errors in indexing the

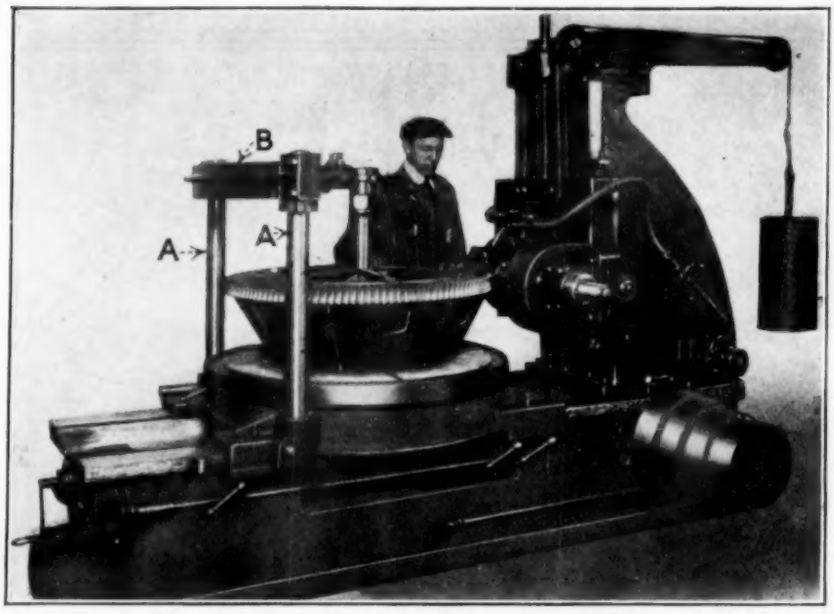


FIG. 2. BELT-DRIVE SIDE OF HOBBING MACHINE

table will result. In this respect the plan contrasts with that of using a small worm gear of much less diameter than the table, which would multiply any errors in indexing. The table drive worm is located in the housing *D* and is driven by the shaft *E*. This crucible-steel worm is 10 in. in length and has a large wearing surface. The worm shaft *E*, which projects through both sides of the worm housing, is driven through change gears. The worm is splined to the shaft so that it may slide back and forth with the table. The table is supported by a combination flat and taper bearing so arranged as to prevent any motion between the table and the saddle. The heavy cast-iron table brackets which are used to support the gear are standard equipment on all machines.

A heavy work arbor is located in the center of the table, this being 2¾ in. in diameter with a working face of 18 in. The lower end of the arbor is tapered to fit in a heavy flanged collar, which is bolted to the face of the table. This collar is provided with the nut by which the arbor may be pulled into place.

The two corner supports *A*, Fig. 2, are 3 in. in diameter and are held at the top by the casting *B*, which supports the upper end of the work arbor and binds all together in a substantial manner. The upper end of the work arbor runs in a bronze bushing. This arrangement is only used for supporting the arbor when heavy cuts are being made and need not be removed from the machine when not in use, for by loosening a cap at one end it may be swung out of the way as shown in Fig. 1.

Two hob arbors are furnished. These are 1¼ and 1½ in. in diameter and are ground to fit the crucible-steel spindle to which they are keyed. The spindle has a front bearing 2¾ in. in diameter and a rear bearing 2¾ in. in diameter and runs in special bronze-composition bushings which are adjustable for wear. The spindle drive is through a set of wide-faced herringbone gears which are used to give smooth action. The arbor head is of the swivel type and may be set to the desired angle by means of the hand-driven wormwheel *F*.

All gears are cut. The shafts are ground and run in bronze bearings. A sheet-metal dust case is provided to inclose the gears, but this was not in place when the photograph for the illustration was taken.

The standard machine is belt driven to a four-step cone pulley with a large step 16 in. in diameter and small step 12¼ in. in diameter. The cone faces are 4½ in. wide From the pulley drive shaft the drive is backgeared so that eight spindle speeds are obtained, ranging from 38 to 115 r.p.m. with the countershaft running at 350 r.p.m. A feature of the design is the centralized control After being started the machine is automatic and the feed is disengaged when the operation is completed, thus making it possible for one man to operate several machines. The column feed control is thrown into service by means of the hand lever *G*, Fig. 1, which causes a worm to engage with the drive gear; a stop *H* is then set for the proper height on the rod *J*, and when the stop on the column saddle meets this the rod is drawn down and the worm is positively disengaged by a spring-operated device. The column saddle is counterweighted, as will be noticed.

Both the head and table feeds are operated by either hand or power and are automatically disengaged when desired. The table feed varies from 0.005 to 0.060 in. and the head feed from 0.010 to 0.120 in. per revolution of the table. A set of change gears is furnished for the feed and division mechanisms, together with charts showing the method of procedure in attaching them.

A Shattered Ideal

BY JAMES H. FOLLEN

Back in the halcyon days of Big Bicycle Business an amount of gray matter was expended in developing the "chainless" bicycle that viewed in the light of present-day problems seems unwarranted.

I well remember working in the toolroom of one large factory where such a machine was developed, and the "engineer" was so proud of his conception that he caused a model to be made with gear cases and tubes partly cut away to show its construction, and this was mounted on a suitable base, like a piece of statuary, and placed on exhibition in his office.

It was the custom of this particular factory to designate one day each week as "visitors' day" when parties of tourists and sightseers as well as really interested people would be piloted through the shop by duly qualified guides who took good care that the "guests" didn't see anything they ought not to.

On one such occasion the before-mentioned engineer was proudly demonstrating the model of his pet idea to a group in which were several representatives of the rural districts when he received a severe psychological shock as one of the farmers turned to a companion and said: "Gosh, Jim! She's cogged up jest like your one-hoss mowin' machine."

LATEST DEVELOPMENTS IN THE AUTOMOTIVE INDUSTRIES

Aircraft • Motor Trucks • Tractors

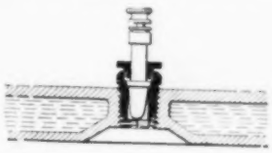
Original research work in airplane construction is being undertaken by the Department of Mechanical Engineering at the University of Toronto, Canada. An air tube, the first of the kind made in Canada, 4 ft. in diameter and 60 ft. in length has been constructed and will be used in the experiments.

Announcement has been made by Glenn H. Curtiss, president of the Curtiss Engineering Corporation, Garden City, L. I., for a daily Curtiss airplane line to be operated next spring from New York to Atlantic City. This may possibly be extended to Newport News and Charleston, S. C. Both passenger and small-package freight service is proposed for this transportation line.

Orville Wright, in an article, "The Future of Civil Flying," published in *Aviation and Aeronautical Engineering*, sets forth the characteristic features regarding the safety of airplanes, saying: "In order to create a real sport it will be necessary to provide means for cross-country flying without risk. There are several ways in which this can be accomplished: (1) The perfection of the flying machine and motor to that degree where forced landings will never be necessary; (2) the establishment of distinctly marked and carefully prepared landing places at such frequent intervals that one could always be reached in case of sudden stoppage of the motor and (3) the development of airplanes of such design as will permit landing in any ordinary field encountered in cross-country flying."

The center of interest in the airplane industries at present is directed toward commercial aerial transportation, and activities, such as locating aerial lines for commercial transportation and developing a type of airplane which will solve successfully the scientific and technical problems of an undertaking of this kind, are noticeable almost in every country of the world. The wonderful records of long-distance flights, such as the London-Cairo of 2900 miles; Cairo-Calenta, 3900 miles; London-Constantinople, 2000 miles; San Diego (Cal.)-Mineola (L. I.), 4000 miles, etc., are showing a very promiseful future for aerial transportation. Still, as a successful business proposition, it has to deal first with assuring the public of the safety of this means of transportation.

The type and the location of a spark plug are important factors in the kerosene-burning tractor engine because the spark plug is one of the common sources of preignition. A plug with a heavy metal body and heavy wire electrodes presents a large heating surface to the burning charge and often becomes red hot, causing excessive pre-



ignition. The plug should preferably be located in the center of the cylinder head in a well-water-jacketed position, so as to be cooled as much as possible. The proper location for a spark plug is shown in the illustration. A spark plug placed in a valve cap, especially over a hot exhaust valve, cannot be cooled, and will burn up and cause preignition when kerosene is used as fuel.

Reports are rife in financial circles that unusually large orders for farm machinery have been placed by France and Italy. This has had the effect of steadying the demand for agricultural machinery. As a result of the war American machinery, having already a considerable prestige abroad, is coming into high continental favor, especially in the allied countries. The greater part of the Italian orders for farm machinery was booked by the J. I. Case Threshing Machine Co., which is preparing for very large trade in the farm-tractor line.

The question of lengthwise stability of tractors demands the serious consideration of the designers. It is very well known that in a tractor, when the power is applied to the drive, weight is automatically shifted from the front to the rear wheels and the machine has a tendency to "rear." Under ordinary operating conditions the turning moment due to this torque reaction is not equal to the opposing weight moment around the rear axle, and there is no other result than that the steering may become somewhat erratic owing to the front wheels being pressed insufficiently against the ground. As the rearing is closely connected with the distribution of weight and with the wheelbase it seems to be preferable to use a fairly long wheelbase and to place an ample amount of weight forward.

The cost of operating the United States Post Office Department motor-truck service during the year ended June 30, 1918, was $292,024. Ford trucks in the service were run at a cost per truck per hour of 81c. in New York, 40c. in Boston and 36c. in Washington. For the White ¾-ton truck the costs were 59c. per hour in Boston and 49c. in Washington. The net income for three months from July 1 to Sept. 30 was $89,861. The Post Office contemplates operating 600 routes with 2000 trucks, which will cost $8,794,000.

The Loening two-seater fighting monoplane constitutes one of the most interesting developments in fighting airplanes of original American design. In its official tests at McCook Field, Dayton, Ohio, the machine flew at a speed of 145 miles with a military load of two men, four machine guns and 2000 rounds of ammunition, climbing 10,000 ft. in 8 min. and maintaining its speed well up to high altitudes. The ceiling of the machine is 25,000 ft. Eliminating all the common monoplane-wing wire stays and using large bracing struts of combined steel tubing and

wood are supposed to explain the remarkably low 4.5-to-1 aspect ratio, giving a span of 32 ft. by 7 ft. chord for the monoplane. The body is very deep and built up of a series of veneer bulkheads much on the order of a hydroplane boat or a torpedo-boat destroyer. It is driven by a Simplex-Hispano 300-hp. motor and the whole power plant is a unit construction and may be easily moved from the body of the plant. The plane stores sufficient fuel for 3½ hours, weighs 1300 lb. and carries practically the equivalent of its entire weight in live load. The seats are so arranged as to give the pilot 50 per cent. more range of vision than in any other machine, and is due to the manner in which the wing has been mounted on a level with the pilot's eyes. During the tests stability and control in maneuvering have been found so satisfactory that it may be said to be one of the first load-carrying machines that can be maneuvered like the smallest single seater. The machine has a very low landing speed, having a 100-m.p.h. speed range, showing another important feature if comparing its low landing speed with the 8-lb. load per square foot of wing surface.

Sparks from the

Some Information Concerning Ocean Freight Rates

A Cincinnati Machine Company Receives Letter on Difficulties in Handling Foreign Trade

Some definite information on ocean freight rates as one of the difficult factors in handling foreign trade is contained in a letter received by Arthur C. Pletz, general manager of the Morris Machine Tool Co., Cincinnati, Ohio, from the company's London representatives, A. A. Jones & Shipman, Ltd. In reply to a letter from the Morris company regarding shipments in future the London company said:

"We are in receipt of your letter of Dec. 7, with further reference to the question of your lathes to be delivered at the rate of three or four a month. We are certainly interested in this proposition and would have cabled our acceptance of your offer only we are prevented from doing this by the uncertainty of the freight situation.

"As you are probably aware, during the past two years we have been importing machines on government-controlled space at the government freight rates. In other words, the shipping companies had to carry machines and tools as well as other government essentials at a maximum freight rate which during the past six months has been $20 a ton. A fortnight ago the restrictions on the shipping companies were removed, and we are informed by the Ministry of Munitions that we now have to import at open-market freight rates. The prevailing freight rates are $6.50 per 100 lb., which you will readily see figures out seven times more than the government rates. We also would say that the freight basis for your lathes is cubic measurement, reckoning 40 cu.ft. to the ton. If you figure out you will observe that the percentage of freight rates to the actual cost is enormous, and candidly we dare not import the machines until we are certain that the freight market is more satisfactory.

"We have taken the matter up with the government department and also the manufacturers' and exporters' associations to which we belong, and we hope pressure will be brought to bear, insisting that there is an immediate reduction.

"We quite appreciate that you have not advanced your prices to any unreasonable extent, but when we have to calculate a freight charge alone of $750, apart from other shipping expenses, such as cartage, handling charges, insurance, storage, etc., you will quite understand that the situation bristles with difficulties.

"We are hopeful that the action taken will have an early effect. In the meantime if it is possible for you to bring pressure to bear on your own government with a view to getting its influence at work on this matter we shall be glad if you will do so."

In the view of the obvious bearing of this situation upon the entire machinery trade Mr. Pletz has brought the matter to the attention of other Cincinnati manufacturers, and it is possible that it will result in some action to obtain government intervention, as suggested in the last paragraph quoted.

* * *

Screw Thread Commission Will Meet This Month

The National Screw Thread Commission it is reported will call a public meeting in New York this month for the purpose of discussing with engineers and manufacturers its findings regarding screw-thread standardization. A great deal of information has been accumulated by means of public meetings and correspondence covering various screw-thread practices, including screw bolts of various forms of threads, machine screws, hose couplings, brass tubing, pipe threads, basis of fit of screw and nut, and classification and tolerance for various forms of fit.

The commission is composed, by an act of Congress, of representatives of the Army and Navy, Bureau of Standards, American Society of Mechanical Engineers, Society of Automotive Engineers, and has its headquarters at the Bureau of Standards, Washington. It was appointed Sept. 21, 1918, for a period of six months.

* * *

Watches Designed for Blind Soldiers

Watches with elevated numbers on the dials and with minute bell systems which ring the hour, half hour and quarter hour have been presented to many blind soldiers in Italy by a committee of women organized for the purpose. Special watches have been designed and made which enable those blinded to know the time by using either their sense of touch or hearing or both. The originator of the idea is a resident of Como, Italy, who wishes to remain incognito.

* * *

Italian Machinery Imports

An association has been formed at Milan by the most important firms in Italy carrying on an important trade in industrial machinery and machine tools from allied countries. Its purpose is the study, protection and promotion of all those interests appertaining to the importation of the articles mentioned.

Labor Department Sends Investigators Abroad

An employers' commission has been designated by William B. Wilson, Secretary of Labor, to study labor conditions and governmental labor policies in Great Britain and report thereon to the department.

The commission consists of Dorr E. Felt, Chicago, connected with the machinery industry; R. J. Caldwell, New York, the textile industry; W. H. Ingersoll, New York, watch industry; Eldon B. Keith, Boston, shoe-manufacturing industry; R. R. Otis, Atlanta, building industry, and E. T. Gundlach, Chicago, publishing industry. Mr. Gundlach was connected with the war service of the Department of Labor during the war, but returned last month to his private business.

The commission will be accompanied by an economic adviser, Dr. Royal Meeker, Comissioner of Labor Statistics, and by James R. Hawkins of New York as fiscal agent, George E. McIlwain of Boston as secretary, and Benjamin M. Squires of New York, Edgar N. Phillips and John A. Witt of Chicago as assistants.

* * *

Portable Wooden Houses to Be Used in France

The technical service of reconstruction has placed orders with private contractors throughout France for about 25,000 demountable wooden houses with two rooms and a shed in each case, costing $700 to $1000 each, and for 10,000 demountable wooden farm buildings to cost $150 to $800 each.

Between 3000 and 4000 of these had been set up at the Somme, at the Aisne and the Oise before the German advance last spring, all of which were lost. To date there are between 1000 and 2000 of these demountable buildings either in the newly liberated regions or on their way there, the great difficulty being to get transportation and the necessary labor for mounting them. Since the armistice, however, the labor problem is being solved rapidly.

To prepare for eventual full reconstruction the technical service of reconstruction of the Government is organizing a bureau to purchase building material in advance. It is expected that a credit of $60,000,000 will now be voted to this bureau, $20,000,000 to be available to house and feed workmen in the devastated regions while they are starting reconstruction. Materials and housing from the Government storage yards will be allocated to coöperative groups of contractors according to priority rules.

World's Industrial Forge

By E.C.Porter, News Editor

Suspension of French Iron and Steel Consortium

According to a cablegram of Jan. 16, 1919, from the clerk to the American commercial attaché at Paris the French Ministry of Industrial Reconstruction has announced that the control of the Iron and Steel Consortium over imports was withdrawn from Jan. 2, 1919, and stocks on hand are being liquidated. The consortium will continue to exist solely for the liquidation of stocks of iron and steel now held in various parts of France. Hereafter applications for license to import iron and steel should be addressed direct to the Ministry of Industrial Reconstruction, Raw Materials Section, Bureau of Importations. Refusal or approval of applications for licenses will be given within three days. It is understood that American firms and their affiliations will be given the same consideration in the matter of granting licenses as is given French firms.

* * *

Electric Welding in Shipbuilding

The subject of electric welding in connection with the building of steel ships by the American Government was discussed at some length by Comfort A. Adams, president of the American Institute of Electrical Engineers, in the course of an address which he gave before the Chicago engineers on Dec. 30, 1918. Both the processes of spot welding and arc and electric welding are applied to shipbuilding. A committee appointed by the A. I. E. E. to make an investigation of the subject concluded that the operator is the principal factor in arc-welding, the type of current regulation being of relatively small importance compared with his skill in manipulating the arc. In a test of 15 different makes of arc-welding appliances no appreciable difference in the strength of the weld was found, all showing a strength of at least 94 per cent. of that of the plate itself.

The test showed also that the strength of the weld was increased to a certain degree as a stronger current was used and that apparently it made no difference whether the current was alternating or direct.

Another point that was deduced from the test is that it apparently makes no difference in the results whether the electrode used is of absolutely pure iron or of an iron containing small impurities, since the characteristics of the metal change in going across the arc.

Particular investigation as to the effect of vibrations in producing fatigue of the metal of the welds was made, and in one set of tests alone the committee used 20 tons of samples. The relative strength of 94 per cent. of the value of the plate as produced by arc-welding can be appreciated when compared with that of a riveted joint, which ranges from 50 to 70 per cent., depending upon whether one, two or three rows of rivets are used.

Spot-welding as compared with arc-welding has the disadvantage that very heavy machinery is required. For welding a ½-in. plate the machine will weigh about 3 tons and consume a large amount of electric current. It, however, requires less time and labor, and the reason for the heavy weight is the necessity for producing a pressure of approximately 25 tons when ½-in. plate is being welded. For spot-welding, the power requirements range from 400 to 700 kw. in the commercial machines, and a machine is being used experimentally which is rated at 2000 kilowatts.

The Classification Committee of the Underwriters, which passes on metals before they are insured, has approved of arc-welding for the minor parts of ships, of which there are about 500,000 on each vessel produced in yards like that at Hog Island.

A 125-ft. barge has been built as an experiment in which all the plates were joined by electric-welding, a saving of about 20 per cent. resulting over riveted barges of the same character built in the same yards.

* * *

Three Billion Meals Eaten by Soldiers During the War

Food stores for the Army on hand in the United States, its possessions, France and in transit to France on Jan. 1, 1919, were valued at $300,000,000. At the time of the signing of the armistice approximately 10,000,000 lb. of food were being consumed by our troops in France each day, and there were on hand in France at that time 1,000,000,000 lb. of food in reserve. All this food had been transported on an average of 5000 miles.

It is estimated by the Subsistence Division that 3,000,000,000 meals were served to the Army during the 19 months of warfare with Germany.

* * *

Encouraging Mechanical Skill

Everyone is interested in the continuance of American industrial prosperity. The announcement contained in the single-page insert in this issue tells about the biggest step that can be taken to safeguard the industries of America by the fostering of American mechanical skill.

National Service Committee in Washington Office

Engineering Council Establishes Service for Engineers—Names of Members Announced

In order more completely to provide for united action on matters of common concern to engineers the Engineering Council has recently organized a National Service Committee and has established an office in the national capital. This action was based on a tentative plan for representation of engineers at Washington submitted to the council at a special meeting on Nov. 21, 1918, by Philip N. Moore of the American Institute of Mining Engineers. (See the December *Proceedings* of the American Society of Civil Engineers.) The present member societies of the Engineering Council are the American Society of Civil Engineers, the American Institute of Mining Engineers, the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, the United Engineering Society and the American Society for Testing Materials.

The Engineering Council, through this National Service Committee and its Washington office, intends to accomplish the following general purposes, this committee acting always under the direction of the council and within limitations fixed for it:

1. To discover public services which may best be performed by engineering societies and, when desired, to offer the proper men for such services.

2. To speak authoritatively for the Engineering Council before committees of Congress and departments of the Government on all public questions of common interest to engineers within such limitations as the council may set from time to time.

3. To give promptly wide circulation among engineers to authentic information regarding pending legislation and executive actions which may affect the interests of engineers in any way.

4. To gather opinions of engineers on these matters.

The Engineering Council's aim is disinterested usefulness to the nation and the profession—not advocacy of any selfish ends—by giving unbiased information and counsel on technical matters, chiefly when asked. A modest start is being made. The work will be enlarged only as a real demand for services develops.

The members of the National Service Committee have been chosen so as to represent different parts of the country. The appointees are the fol-

lowing: Chairman, M. O. Leighton, M. Am. Soc. C. E., Washington, D. C.; C. B. Burdick, M. Am. Soc. C. E., Chicago, Ill.; George F. Swain, M. Am. Soc. C. E., Boston, Mass.; Philip N. Moore, M. A. I. M. E., St. Louis, Mo.; L. D. Ricketts, M. A. I. M. E., Warren, Ariz.; Andrew M. Hunt, M. Am. Soc. M. E., San Francisco, Calif., and New York; Andrew M. Lockett, M. Am. Soc. M. E., New Orleans, La.; W. C. L. Eglin, M. Am. I. E. E., Philadelphia, Penn.; Bancroft Gherardi, M. Am. I. E. E., New York.

The Washington office is located at 502 McLachlen Building, 10th and G Streets.

* * *

Invention of Ball Bearings Credited to Chinese

Like many other inventions, China is now claimed to be the originator of ball bearings. The use of these, it is said, goes back to a very early date, regardless of the claim that the first commercial steel balls were made in the United States and that the original ball-making machines for the plant of the largest foreign maker were designed and built in America.

The swiftest airplane and the fleetest automobile now depend on ball bearings for their speed, and according to a British authority the use of steel ball bearings has increased so greatly in the last decade that they are now employed in machines where plain bearings were formerly considered good enough.

* * *

Conference of Employers and Employees

The second of a series of conferences arranged by the New Jersey State Chamber of Commerce between employers and employees was held at the Railroad Club, 30 Church St., New York, on Tuesday, Jan. 28, 1919.

The subject discussed was the self-government of industrial establishments through some form of congress in which employer and employee are represented. Invitations were extended to many establishments and organizations throughout the eastern section of the country, which have in operation some system of employee's representation, to send delegates from both employers and employees.

The object of the conference is to correlate such knowledge as may be available through experience with the various systems now in operation, with a view to disseminating this information for the benefit not only of the organizations represented but of industry in general.

The services of the Bureau of Industrial Research of the Chamber of Commerce are to be available for the purpose of gathering information relating to the various phases of the subject, and a committee of eight was appointed by the conference to determine more fully the lines along which the research work should be directed.

Business Items

Hill-Clarke & Co., Chicago, Ill., are erecting a two-story brick building at 647 West Washington Blvd., to be used as a display room and office. The estimated cost of construction is $40,000.

The W. G. Runkles Machinery Co., Trenton, N. J., has been incorporated for $125,000 to manufacture machinery. The incorporators are W. G. Runkles, Trenton, N. J.; Charles T. Clarke, Trenton, and C. C. Klockner, Fallsington, Penn.

The Beckwith Machinery Co., Pittsburgh, Penn., has opened an office and warehouse at 1227 West Ninth St., Cleveland, Ohio, where it will handle a complete line of construction equipment. The office will be in charge of E. G. Stoner, who will be assisted by C. Z. Dally.

The Manufacturers' Hardware Corporation, Milwaukee, Wis., has been incorporated with a capital stock of $100,000 to manufacture and sell machinery, accessories, supplies, etc. L. E. Beeman, head of the Universal Manufacturing Co., New York, is one of the incorporators.

H. W. Reed and F. A. Hickernell have formed a sales organization under the name of Reed & Hickernell, engineers, with offices in the Munsey Building, Washington, D. C. They are representing manufacturers of products purchased by the Government and the Southeastern railroads.

Personals

WILLIAM K. SWIFT, has become a member of the sales department of the Bound Brook Oil-less Bearing Co., Bound Brook, N. J.

CAPT. ROY T. MIDDLETON, formerly Detroit manager of the Steel Products Co., has become general representative of the Standard Steel Casting Co., Cleveland, Ohio.

JOHN W. SADLER, tool engineer of the ordnance department of David Lupton's Sons Co., Philadelphia, Penn., has been made supervisor of the tool and machine shop of the company.

HERBERT W. GLADHILL, formerly sales engineer at the Philadelphia office of the Shepard Electric Crane and Hoist Co., has been made district manager of that office.

THEODORE F. OECHOLE, formerly supervisor of the tool and machine shop of David Lupton's Sons Co., Philadelphia, Penn., has recently become consulting engineer of that company.

EDWARD A. CORDES, formerly master mechanic of the Fairbanks-Morse Manufacturing Co., Beloit, Wis., has become superintendent of the Standard Steel Car Co., ordnance department, at Hammond, Ind.

H. P. EILERS, who for the past 17 years has been in the machinery business in New York, has taken up the same work on his own account in Los Angeles, where he intends to make his permanent home.

MARGARET A. GERRITY, 548 Orange St., New Haven, Conn., formerly with the Marlin-Rockwell Corporation, New Haven, Conn., is now representing Flint & Chester, Inc., New York, dealers in machinists' supplies, in Connecticut, Rhode Island and vicinity.

CAPT. EDWARD E. ASHLEY, JR., for many years consulting mechanical and electrical engineer of Starrett & Van Vleck, architects, New York, has resigned his commission in the Air Service of the United States Army to accept an appointment as sales engineer of the Mercury Manufacturing Co., Chicago, Ill., manufacturer of electrically driven tractors.

Obituary

ADELBERT E. ELLIS, president of the Hart-Parr Co., died Jan. 12 at his home in Charles City, Iowa, in his 70th year.

COL. BENJAMIN ADRIANCE, president of the Adriance Machine Works, Inc., Brooklyn, N. Y., died at Miami, Fla., Jan. 3, 1919.

HENRY C. BARTELD, head of the electrical department of the Honolulu Iron Works, died on Jan. 11, 1919, at the home of his mother, 177 Hancock St., Brooklyn, N. Y. He was a graduate of Adelphi Academy and of Columbia University.

EUGENE C. MERGENTHALER, second son of Ottmar Mergenthaler, inventor of the Linotype machine, died Jan. 4, 1919, in Baltimore, from pneumonia. He was 33 years old and received his college education at Cornell and at Karlsruhe (Germany). He followed the lead of his father into the mechanical and inventive fields and was president of the Mergenthaler Co., manufacturer of reamers, etc., and president of the Simplex Protective Stopper Co. at his death. For the past two years he had been almost wholly occupied in Government work.

J. J. MCCABE of the J. J. McCabe Lathe and Machinery Corporation, New York, well known in the machine-tool industry as a dealer and manufacturer, died on Jan. 17, 1919. As a dealer he handled the agency in New York from time to time for such concerns as Schumacher & Boye, Smith & Mills Co., Charlton Machine Tool Co. and G. A. Gray Co. He designed and manufactured under his patents for a number of years the "2-in-1" double-spindle lathe. Mr. McCabe was a pioneer in the used-machinery business, having succeeded the old New York firm of E. P. Bullard Co. nearly 35 years ago. A few years ago he founded

the present J. J. McCabe Punch & Shear Co. with a plant at Chattanooga, Tenn. He is survived by a widow and four children. Two of his sons—J. J., Jr., and Raymond J.—have been associated with him in business for a number of years and will continue the organization of the J. J. McCabe Lathe and Machinery Corporation and the J. J. McCabe Punch and Shear Company.

BURT O. GAGE, widely known as an inventor and pump expert, died at his home in Warren, Mass., Jan. 9, 1919, after a few days' illness of bronchial pneumonia. He was in his 76th year. Mr. Gage had been associated nearly all his life with the pump industry, entering the employ of the Knowles & Sibley Co., manufacturer of steam pumps, in 1867. For about 40 years he was associated with this concern and its successors, the George F. Blake Manufacturing Co. of Warren and Boston, during which time he patented many useful and practical ideas in pumping machinery. In 1905 he became associated with the Warren Steam Pump Co., Warren, Mass., as superintendent, which position he held at the time of his death.

Trade Catalogs

Stock List. The Advance Tool Co., Cincinnati, Ohio. Catalog. Pp. 14; 8½ x 11 in. Here are given illustrations and specifications of small tools made by this company, including counterbores, cutters, mills, mandrels, reamers, collets, gages, etc.

Multiwhirl Cooler. The Griscom-Russell Co., 90 West St., New York. Catalog. Pp. 12; 6 x 9 in. The uses, construction, specifications and advantages of this product are given, together with halftone illustrations showing interior and exterior views.

Link-Belt Equipment for the Handling and Preparation of Coal at the Mine. Book No. 333. Link-Belt Co., Chicago, Ill. Pp. 88; 6 x 9 in. This shows the various types of coal-mine equipment furnished by the Link-Belt Co. There are many halftone illustrations of complete installations.

Metal Cutting Tools. Lovejoy Tool Co., Inc., Springfield, Vt. Catalog. Pp. 16; 6 x 9 in. Here is described and illustrated this company's line of patented inserted-cutter tools, including left and right hand turning and facing tools, boring or facing bars and shaping and planing machine tools.

Star Safety Friction Clutch. Carl G. Westlund Co., Worcester, Mass. Catalog No. 10. Pp. 15; 5½ x 7½ in. Price lists and specifications of bushings, friction clutches, cutoff couplings and split clutches, together with illustrations and a description. The last two pages give illustrations of the Westlund engine lathe.

Buildings: Industrial and Commercial. The Gaylor W. Feaga Co., Cleveland, Ohio. Catalog. Pp. 24; 8½ x 11 in. Presenting information on the ability and experience of this company of constructing engineers and telling about industrial construction, the organization and standardization of factory buildings, records of construction and some reminiscences of pioneer construction.

The Grand Rapids Drill Grinder Book. Grand Rapids Grinding Machine Co., Grand Rapids, Mich. Pp. 32; 8½ x 11 in. This book is just off the press and portrays the Grand Rapids line of drill-grinding machines in an adequate manner, giving many line drawings and halftone illustrations. Pages 27, 28 and 29 give some helpful hints on the care and use of twist drills and should make the book valuable to any drilling-department or tool-crib foreman. A copy may be obtained by interested parties on request.

New Publications

The Internal Gear: Its Design and Application.—Ninety-four 6 x 9-in. pages; 56 illustrations, 7 tables. Published by the Fellows Gear Shaper Co., Springfield, Vermont. Free to those interested in gears.

In the preface the compilers of this book say: "The development of various forms of reduction gear drives where compactness is an essential factor has brought the internal gear into prominence. While it is generally conceded that the internal gear has certain limitations it is also known that it has several advantages over the external gear, especially from the standpoint of efficient tooth action. Its good features, however, stand out more prominently when compared with other forms of drives used for reduction purposes. It is not the object of this treatise to deal extensively with the various forms of reduction-gear drives, but to explain in the simplest possible terms advantages and limitations of the internal gear. Many of the so-called limitations can be easily overcome by a proper understanding of the conditions that must be met. One so-called limitation of the internal gear was the difficulty of cutting." This last limitation is of course not valid since a gear shaper will cut an internal as easily as an external gear.

The chapters of the book are: Definition and Advantages of the Internal Gear, Design of Internal Gears, Graphical Analysis of Tooth Action of Internal Spur Gears, Internal Helical Gear Design, Cutting Internal Gears and a Variety of Applications of the Internal Gear. Altogether the book contains a large amount of data, especially on the cutting of internal spur and helical gears, and it will make a valuable addition to the library of anyone interested in gears.

Graphical and Mechanical Computation.—By Joseph Lipka, Ph.D. Two hundred and sixty-four 5¾ x 9-in. pages; 110 charts and illustrations; bound in cloth boards. Published by John Wiley & Sons, Inc., New York. Price, $4.

This book embodies a course given by the author in the mathematical laboratory of the Massachusetts Institute of Technology where he is assistant professor of mathematics. It is intended as an aid in the solution of a large number of problems which the engineer as well as the student meets in his work. In the first chapter the construction of scales leads to the discussion of the principles upon which the construction of various slide rules is based. The next chapter develops the principles of a network of scales, showing their applications to the use of various kinds of coördinate paper and to charting of equations in three variables.

Engineers have long recognized the value of graphical charts in lessening the labor of computation. Among charts devised none is more rapidly constructed or more easily read than the alignment or nomographic type. Chapters III, IV and V aim to give a systematic development of the construction of alignment charts. The methods are fully illustrated by charts for a large number of well-known engineering formulas. Many formulas in the engineering sciences are empirical, and the value of many scientific and technical investigations is enhanced by the discovery of the laws connecting the results. Chapter VI is concerned with the fitting of equations to empirical data. Chapter VII considers the case where the data are periodic, as in alternating currents and voltages, sound waves and so on, and gives numerical, graphical and mechanical methods for determining the constants in the equation. When empirical formulas cannot be fitted to the experimental data, these data may still be efficiently handled for purposes of further computation—interpolation, differentiation and integration—by numerical, graphical and mechanical methods developed in the last two chapters. Numerous illustrative examples are worked throughout the text, and a large number of exercises for the student is given at the end of each chapter. Additional charts in the back of the book serve as an aid in the construction of alignment charts. The specific chapter headings are: Scales and the Slide Rule; Network of Scales; Charts for Equations in Two and Three Variables; Nomographic or Alignment Charts (three chapters); Empirical Formulas—Nonperiodic Curves; Empirical Formulas—Periodic Curves; Interpolation; Approximate Integration and Differentiation.

Industrial Engineering. A Handbook of Useful Information for Managers, Engineers, Superintendents, Designers, Draftsmen and Others Engaged in Constructive Work. Vol. 1.—By William M. Barr, Six hundred and nineteen 6 x 9-in. pages, numerous tables and illustrations; bound in brown cloth boards. Published by the W. M. Barr Co., Inc., 116 West 39th St., New York. Price, $4.

In the preparation of this book the author attempts a systematic arrangement of a large volume of information for engineers which has not previously been readily available. There is considerable data relating to specifications of the chemical and physical properties of most of the materials entering into Government engineering work. Not only are these data valuable to those engaged on Government work, but they are useful to those in every department of industrial engineering. The nature of the data is very practical, a feature made possible by the free use of working drawings. These drawings are used throughout the book and in many cases are accompanied by tables of working dimensions. The author's aim has been to so arrange these data that the principal dimensions given in any table may with suitable adaptations be used directly in the preparation of shop drawings without the labor of recalculation. The data relating to the strength of materials are those wholly obtained by direct experiment; mainly in testing machines owned and operated by the Government.

There will be noticed throughout the book a tendency toward steam-engine details, due no doubt to the author's long familiarity with this subject. The present volume is the first part of what is intended to be a two-volume series. The second volume, to follow shortly, will deal more with machinery, fittings and equipment in general than does this volume.

As an engineering and a general reference book this volume will prove of considerable value. The chapter headings, which only hint at the very large range of subjects, are: Units and Standards; Weights and Measures; Mensuration and Mechanical Tables; Properties of Some Materials Used in Engineering; Steel Bars, Plates, Shapes, Bolts, Rivets; General Specifications for Inspection of Material, Navy Department; Iron and Steel Castings; Iron and Steel Forgings, Carbon and High-Speed Steels, Heat Treatment; Nonferrous Metals and Alloys; Machine Details, Principally Those Relating to Steam Engines and an Index.

Forthcoming Meetings

Boston Branch National Metal Trades Association. Monthly meeting on first Wednesday of each month. Young's Hotel. Donald H. C. Tullock, Jr., secretary, Room 41, 166 Devonshire St., Boston, Mass.

Engineers' Society of Western Pennsylvania. Monthly meeting, third Tuesday; section meeting, first Tuesday. Elmer K. Hiles, secretary, Oliver Building, Pittsburgh, Penn.

New England Foundrymen's Association. Regular meeting, second Wednesday of each month. Exchange Club, Boston, Mass. Fred F. Stockwell, 205 Broadway, Cambridgeport, Mass.

Philadelphia Foundrymen's Association. Meeting first Wednesday of each month. Manufacturers' Club, Philadelphia, Penn., Howard Evans, secretary, Pier 45, North Philadelphia, Penn.

Providence Engineering Society. Monthly meeting fourth Wednesday of each month. A. E. Thornley, corresponding secretary, P. O. Box 796. Providence, R. I.

Rochester Society of Technical Draftsmen. Monthly meeting, last Thursday. O. L. Angevine, Jr., secretary, 857 Genesee St., Rochester, N. Y.

Superintendents' and Foremen's Club of Cleveland. Monthly meeting, third Saturday. Philip Frankel, secretary, 310 New England Building, Cleveland, Ohio.

Technical League of America. Regular meeting, second Friday of each month. Oscar S. Teale, secretary, 240 Broadway, New York.

Western Society of Engineers, Chicago, Ill. Regular meetings, first, second, third and fourth Mondays of each month, except July and August. Edgar S. Nethercut, secretary, 1735 Monadnock Block, Chicago, Ill.

WEEKLY PRICE GUIDE OF

IRON AND STEEL

PIG IRON—Quotations compiled by The Matthew Addy Co.:

	Current	One Month Ago
CINCINNATI		
No. 2 Southern	$37.60	$37.60
Northern Basic	34.80	34.80
Southern Ohio No. 2	35.80	35.80
NEW YORK, Tidewater delivery		
Penna. 2X	39.55	39.15
Virginia No. 2	41.70	41.70
Southern No. 2	41.70	41.70
BIRMINGHAM		
No. 2 Foundry	34.00	34.00
PHILADELPHIA		
Eastern Pa. 2X	39.15*	38.85*
Virginia No. 2	40.50†	40.50†
Basic	36.90*	36.60*
Grey Forge	36.90*	36.60*
Bessemer	39.10*	38.80*
CHICAGO		
No. 2 Foundry Local	34.50	34.50
No. 2 Foundry Southern	39.00	39.00
PITTSBURGH, including freight charge from the Valley		
No. 2 Foundry Valley	35.40	35.40
Basic	34.40	34.40
Bessemer	36.60	36.60

* F.o.b. furnace. † Delivered.

STEEL SHAPES—The following base prices per 100 lb. are for structural shapes 3 in. by ¼ in. and larger, and plates ¼ in. and heavier, from jobbers' warehouses at the cities named:

	New York			Cleveland			Chicago	
	Current	One Month Ago	One Year Ago	Current	One Year Ago		Current	One Year Ago
Structural shapes	$4.07	$4.27	$4.20	$3.97	$4–4.04		$4.07	$4.20
Soft steel bars	3.97	4.17	4.10	4.07	4–4.04		3.97	4.10
Soft steel bar shapes	3.97	4.17	4.10	4.07	4.14		3.97	4.10
Soft steel bands	4.57	4.77						
Plates, ¼ to 1 in. thick	4.27	4.52	4.45	4.47*	4.39		4.27	4.20

* For ⅜-in. plates.

BAR IRON—Prices per 100 lb. at the places named are as follows:

	Current	One Year Ago
Pittsburgh, mill	$3.50	$3.50
Warehouse, New York	4.75	4.70
Warehouse, Cleveland	3.90	4.98½
Warehouse, Chicago	4.10	4.10

STEEL SHEETS—The following are the prices in cents per pound from jobbers' warehouse at the cities named:

	Pittsburgh, Mill, in Carloads	New York Current	New York One Month Ago	New York One Year Ago	Cleveland Current	Cleveland One Year Ago	Chicago Current	Chicago One Year Ago
*No. 28 black	4.70	6.22	6.52	6.445	5.75	6.45	6.22	6.445
*No. 26 black	4.60	6.12	6.42	6.405	5.65	6.35	6.12	6.405
*Nos. 22 and 24 black	4.55	6.07	6.37	6.295	5.60	6.30	6.07	6.295
Nos. 18 and 20 black	4.50	6.02	6.32	6.245	5.50	6.25	6.02	6.245
No. 16 blue annealed	4.10	5.37	5.72	5.645	4.95	5.65	5.37	5.645
No. 14 blue annealed	4.00	5.27	5.62	5.545	4.85	5.55	5.27	5.545
No. 10 blue annealed	3.90	5.17	5.52	5.445	4.75	5.45	5.17	5.445
*No. 28 galvanized	6.05	7.57	7.77	7.695	7.15	7.70	7.57	7.695
*No. 26 galvanized	5.75	7.27	7.47	7.395	6.85	7.40	7.27	7.395
No. 24 galvanized	5.60	7.12	7.32	7.245	6.70	7.25	7.12	7.245

* For painted corrugated sheets add 30c. per 100 lb. for 25 to 28 gage; 25c. for 19 to 24 gages; for galvanized corrugated sheets add 5c., all gages.

COLD DRAWN STEEL SHAFTING—From warehouse to consumers requiring at least 1000 lb. of a size (smaller quantities take the standard extras) the following discounts hold:

	Current	One Year Ago
New York	List plus 9%	List plus 25%
Cleveland	List plus 7%	List plus 10%
Chicago	List plus 9%	List plus 10%

DRILL ROD—Discounts from list price are as follows at the places named:

	Extra	Standard
New York	35%	40%
Cleveland	35%	40%
Chicago	35%	40%

SWEDISH (NORWAY) IRON—The average price per 100 lb., in ton lots is:

	Current	One Year Ago
New York	$25.50–30	$15.00
Cleveland	20.00	15.30
Chicago	16.50	15.00

In coils an advance of 50c. usually is charged.
Note—Stock very scarce generally.

WELDING MATERIAL (SWEDISH)—Prices are as follows in cents per pound f.o.b. New York, in 100 lb. lots and over:

Welding Wire*		Cast-Iron Welding Rods	
1/16, 11/64, 3/32, 1/8, 7/32, 5/16 No. 8, 9/32 and No. 10	25.50 to 33.00	1/4 by 12 in. long	14.00
5/16 No. 12		5/16 by 19 in. long	12.00
3/8, No. 14 and 7/16 No. 18		3/8 by 19 in. long	9.00
No. 20		1/2 by 21 in. long	10.00

* Very scarce.

* Special Welding Wire

1/2	33.00
5/8	30.00
3/4	30.00

MISCELLANEOUS STEEL—The following quotations in cents per pound are from warehouse at the places named:

	New York Current	Cleveland Current	Chicago Current
Openhearth spring steel (heavy)	8.00	8.00	7.50
Spring steel (light)	10.00	11.25	11.75
Coppered bessemer rods	9.00	8.00	7.07
Hoop steel	4.77	4.75	4.77
Cold-rolled strip steel	8.02	8.25	8.57
Floor plates	6.27	6.00	6.25

PIPE—The following discounts are for carload lots f.o.b. Pittsburgh: basing card of No. 6, 1917, for steel pipe and for iron pipe:

BUTT WELD

Steel Inches	Black	Galvanized	Iron Inches	Black	Galvanized
⅛, ¼, and ⅜	47%	20½%	⅛ to 1¼	36%	20%
½	51%	30½%			
¾ to 3	54%	40½%			

LAP WELD

2	47%	34½%	2	29%	15%
2½ to 6	50%	37½%	2½ to 6	31%	18%

BUTT WELD, EXTRA STRONG PLAIN ENDS

⅛, ¼ and ⅜	43%	25½%	⅛ to 1¼	36%	21%
½	48%	35½%			
¾ to 1¼	52%	39½%			

LAP WELD, EXTRA STRONG PLAIN ENDS

2	45%	33½%	2	30%	17%
2½ to 4	48%	36½%	2½ to 4	32%	20%
4½ to 6	47%	35½%	4½ to 6	31%	19%

Stock discounts in cities named are as follows:

	New York Black	New York Galvanized	Cleveland Black	Cleveland Galvanized	Chicago Black	Chicago Galvanized
⅛ to 3 in. steel butt welded	43%	27%	43%	26%	41 1%	26 1%
3½ to 3 in. steel lap welded	38%	29%	39%	23%	37 1%	23 1%

Malleable fittings. Class B and C, from New York stock sell at list +12½%. Cast iron, standard sizes, 10% off.

METALS

MISCELLANEOUS METALS—Present and past New York quotations in cents per pound, in carload lots:

	Current	One Month Ago	One Year Ago
Copper, electrolytic	20.00	26.00	23.50
Tin in 5-ton lots	71.50	72.00	85.00
Lead	5.30	7.05	6.50
Spelter	7.10	8.60	8.00
ST. LOUIS			
Lead	5.00	6.75	6.35
Spelter	6.75	8.25	7.55

At the places named, the following prices in cents per pound prevail, for 1 ton or more:

	New York Current	New York One Month Ago	New York One Year Ago	Cleveland Current	Cleveland One Year Ago	Chicago Current	Chicago One Year Ago
Copper sheets, base	29.00	38.00	31.00	31.00	32.50	32.00	35.00
Copper wire (carload lots)	28.00	35.00	32.00	32.00	28.50	28.50	34.00
Brass sheets	29.00	39.75	30.75	32.00	33.00	29.00	35.00
Brass pipe	37.00	46.00	36.50	38.00	40.00	37.00	41.00
Solder (half and half) (case lots)	41.00	55.00	48.00	44.00	43.25	39.00	41.50

Note:—Solder very scarce.

Copper sheets quoted above hot rolled 16 oz., cold rolled 14 oz. and heavier, add 1c.; polished takes 1c. per sq.ft. extra for 20-in. widths and under; over 20 in., 2c.

BRASS RODS—The following quotations are for large lots, mill. 100 lb. and over, warehouse; 25% to be added to mill prices for extras; 50% to be added to warehouse price for extras:

	Current	One Year Ago
Mill	$26.00	$25.00
New York	27.40	30.00
Cleveland	30.00	34.00
Chicago	28.50	37.00